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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE WAR AND THE CHEMICAL INDUSTRY[1]

PHILADELPHIA was the cradle of chemistry in this country. What was possibly the first chemical society in the world was founded here in 1792. A few years later one of its members addressing the society said:

> The only true basis on which the independence of our country can rest is agriculture and manufactures. To the promotion of these nothing tends in a higher degree than chemistry. It is this science which teaches man how to correct the bad qualities of the land he cultivates by a proper application of the various species of manure, and it is by means of a knowledge of this science that he is enabled to pursue the metals through the various forms they put on in the earth, separate them from substances which render them useless, and at length manufacture them into various forms for use and ornament as we see them. If such are the effects of chemistry, how much should the wish for its promotion be excited in the heart of every American! It is to a general diffusion of knowledge of this science, next to the virtue of our countrymen, that we are to look for the firm establishment of our independence. And may your endeavors, gentlemen, in this cause, entitle you to the gratitude of your fellow citizens.

Considering the time when these words were spoken, we must marvel at the vision of the future which must have illumined the mind of the speaker. If in the last clause quoted he had said "ladies and gentlemen" it would have been complete.

But Philadelphia was also the cradle of the chemical industry in this country, and up to the present day occupies a very important part of that field. Some of the pleasantest recollections of my earlier life

[1] Address complimentary to the citizens of Philadelphia given by Dr. Wm. H. Nichols at the Philadelphia Meeting of the American Association for the Advancement of Science.

are associated with those fine men then prominent here, but now mostly passed on, who made this city respected wherever chemical products were concerned, and not an insignificant part of my youthful enthusiasm was imbibed from them.

Therefore, when I was asked to talk to you on the subject of the war and the chemical industry, I accepted with the hope that I might add something to the general knowledge on the subject, and in a modest way pay a portion of an old debt. In the interval which has elapsed, however, the ground has been covered by many men on many occasions, and I find myself in the position of talking to you on a subject as well understood by most of you as it is by myself. There may be certain phases, however, which will repay further thought, and possibly there may be deductions worth considering. I shall therefore ask your indulgence if I ramble somewhat, and talk largely about what we have not done, avoiding dry statistics as far as possible.

Some of us may be old enough to remember our own civil war. Most of us remember the so-called Spanish war. Any knowledge or experience gained from these wars, intimate as the former was, gives no data on which to base any calculation as to the world-wide results of the present devastating struggle. Even our imaginations are unable to satisfy our judgments, which are more or less consciously or unconsciously influenced by our point of view. It is simply impossible to forecast the results industrial, geographical or moral. The world has never seen anything like it before, and, therefore, reasoning from analogy is entirely out of the question. We know this, however, that where such an enormous number of men are withdrawn from ordinary pursuits, many never to return, and such incalculable damage is done to property, the world must feel for many years to come the effects which this impoverishment must produce. We might just as well accustom ourselves to the thought that before us lie years of painful toil and reconstruction, so that prudence, that great virtue of our forebears, may become more and more a part of us, and drive out the vice of extravagance which has become such a prominent characteristic of our people.

Judging from what we read in the papers, we might conclude that the chemical industry in the United States is in an infantile condition, and hardly worthy of serious consideration. Those not acquainted with the subject are ready to admit without argument that almost any European country is far and away ahead of us in volume and ability to produce economically. A glance at the 13th United States census will dispel at least some of these views, and is well worth taking. It includes under the heading "chemicals and allied products," nine principal divisions, and gives the value of the output of each.

1. Paint and varnish	$125,000,000
2. Chemicals (general)	117,000,000
3. Fertilizers	104,000,000
4. Explosives	40,000,000
5. Dyestuffs and extracts	16,000,000
6. Sulphuric, nitric and mixed acids	10,000,000
7. Wood (except rosin and turpentine)	10,000,000
8. Essential oils	2,000,000
9. Bone, carbon and lamp black	2,000,000

The above values were produced by 2,140 establishments, having a capital of $483,-000,000, and employing 88,000 persons. The census does not state, however, what is probably the fact, that the United States produces more sulphuric acid by catalysis than any other country in the world, and possibly more than all other countries combined. This fact has a bearing on what will be alluded to later, namely, the possible manufacture of coal-tar dyes and other products, for which fuming sulphuric acid is often an absolute necessity.

The census furthermore shows that the return on capital invested in the chemical and allied industries is not so great as in other branches of manufacturing endeavor. This is due to the high initial cost of plant, frequent alterations and reconstructions made necessary by the advance of knowledge, and I imagine by a somewhat senseless competition which has seemed to affect chemical manufacturers for as long as I can remember.

Owing to the enormous territory covered, the conditions governing the industry are quite different from those existing in other countries. Like all industries the greatest economies can be practised in the largest units, but this fact of extensive territory which is served makes numerous small units necessary. The products usually are bulky and low priced, and railroad freights play an important part in the problem. This fact must be borne in mind constantly when comparing the industry in this country with that in any other.

We Americans are apt to pride ourselves on the progress which we have made along manufacturing lines, and take to ourselves great credit for what has been accomplished. In view of the enormous supply of various raw materials which this country has at its disposal, an analysis of what we have done, I fear, would show that instead of taking undue credit to ourselves we should be very humble because we have not done much better. Of course I realize that this is a comparatively new country, and that it took time to get things into working order. Lines of communication had to be constructed, factories had to be built and rebuilt, and all the necessary impedimenta of industry had to be evolved from a condition which, at the time the Philadelphia chemist quoted in the beginning spoke, consisted of little more than forests, prairies and prospects of mines. If during this period of development a good deal of waste occurred, and a number of abuses crept in, it is not so much to be wondered at. We have, however, arrived at a period when it is borne in upon us from all sides that conservation of natural resources, as well as human energy, is absolutely essential if we are to go forward with anything like the strength and certainty to which our resources entitle us.

Of raw materials for the chemical industry, without going into unnecessary voluminous details, we have an abundance—cheap phosphate rock, salt, copper, sulphur, coal, wood, bauxite, zinc. In addition to raw materials, and among our most valuable assets are our college professors of chemistry, who, I am sure, could, if called upon, render additional priceless service to the lasting benefit of the world and of themselves.

On the other hand, we must import much of our sulphur in the form of pyrites, nearly all of our potash, all of our tin, nickel and nitrate of soda. We have large supplies of nitrogen, available from animals and coal. But the great supply of the future is still in the air. This source of supply, however, has up to the present time proved rather difficult of access. Of course it must be secured, but just how is not altogether clear in spite of the good work already accomplished. This is one of the problems which the chemist, chemical engineer and electrical engineer must solve, however, within a comparatively few years, as the nitrate beds of Chili, while still very large, will some time come to an end.

With the Allies in command of the sea the war has not affected any of these raw materials very greatly, except potash. This salt is widely enough disseminated in various forms in this country, but where of hopeful strength it is inaccessible, and

where accessible it can not be produced without expensive plant construction which would probably be useless as soon as the German supply is once more obtainable. In arriving at this conclusion due note must be made of the German costs and not of the German selling prices. The Stassfurt salts can be produced very cheaply indeed, and the price which they have been able to bring in the markets of the world have yielded an enormous profit. This fact, of course, is a determining one when we talk of producing our own potash.

One of the most important of the chemical industries is the manufacture of fertilizers for the soil. We have in this country enormous deposits of phosphate rock, easily accessible and cheaply mined. This rock has been exported in large quantities to Europe and the Orient and is in sufficient quantity to last a number of years even in the careless way in which it has been used. A complete fertilizer, however, requires potash and, as noted above, we have been in the habit for a number of years of getting our potash from Germany, and there is every reason to expect that we will continue to do so for many years to come. If, as one of the results of the war, while it lasts, enough potash can not be obtained to make the fertilizers to which we have been accustomed, I feel that this will not be an absolutely hopeless misfortune. It is quite possible that the propaganda for the use of potash has been carried too far, and that less could be used on the soil without any great disadvantage. At any rate, we will be quite able to furnish an abundance of fertilizers in this country containing phosphoric acid and nitrogen, and if for a while we have to rely more or less upon the soil to furnish its own potash, I imagine we will not suffer beyond redemption. From some quarters in the south and elsewhere I have heard rumors that a smaller cotton crop would be looked upon as a blessing, and it is quite likely that without government or other assistance the natural laws of supply and demand will produce a smaller crop next year, simply because there may not be enough potash to supply the requirements of a large one.

With here and there an exception, the only effect the war has had upon the chemical industry is the effect which it has had upon those industries which consume its output, and I think this can be taken as a general statement covering all articles. Of course, there are notable exceptions, such as smokeless powder and other products required for war purposes.

Some heavy chemicals, the receipt of raw material for which has been very much curtailed or stopped altogether, have advanced sharply in value, but generally speaking the chemical industry has not profited by advanced prices as a result of the war. Owing to reduced home consumption, the result in some cases has been a great falling off in profit, a condition which I trust will not be of long duration. I am a believer that the manufacturing industries of this country will before very long be on the up grade and all of the chemicals produced, speaking generally, will be needed.

More has been talked and printed lately about a portion of the chemical industry which has not taken very deep root in this country, than about all the rest of the industry put together. I refer to the organic chemicals resulting from products of the distillation of coal tar. Many have wondered why the American chemist has not stepped up and taken the place of the foreign manufacturer in supplying the textile and other industries with colors, evidently not understanding the size and complexity of the question. I think it worth while, there-

fore, to discuss this at some length, as it is probably the most pressing question before the chemical world in this country to-day and I fear the one least likely to receive a favorable reply. A few years ago every coke oven in this country was what is known as a bee-hive oven, and all the by-products of the distillation of coal were lost. It is only in comparatively recent years that by-product furnaces have been constructed and various by-products saved. The ammonia was naturally first utilized and the products of the distillation of tar have been among the last. In fact, a theory existed in the minds of many people that the tar produced by American coal did not possess the necessary constituents to make it useful as a basis for the production of organic chemicals. I have been myself told by one of the large producers in Germany that it was absolutely certain that American coal did not possess the necessary qualities. The object of this information was probably to put out of my mind any latent ambition along forbidden lines, but as it was given by the commercial manager and not by one of the scientific staff, I believed him, but wondered if it were true.

In a lecture delivered to the board of directors of the General Chemical Company on October 23, 1914, the subject and its difficulties were outlined by Dr. B. C. Hesse. Owing to the immensity of the subject only a small part of it was treated. This able lecture has since been published in the *Journal of Industrial Chemistry*, but I can not do better than quote from it freely, as I consider it the best exposition of the case that has come to my attention. He says:

At the very beginning it should be pointed out that the world's market in coal-tar dyes, as it stands to-day, comprises, in round numbers, 900 distinct and different chemical substances which are made by the aid of 300 products of transformation, themselves not dyes, of 10 products obtained or obtainable from coal-tar by distillation, refrigeration, expression or the like. Therefore, actually and in reality the present coal-tar dye industry comprises no fewer than 1,200 different products and as many or more different processes of manufacture and requires many hundred different sets of apparatus of varying capacity and of different kind for many hundred different operations. A manufacturing problem comprising so many independent and yet interlaced units of manufacture and production has therefore within it many elements of complexity.

World's figures are not available. The fullest, best, most dependable and most recent figures are those dealing with Germany. In the year 1913 the total export value of Germany's coal-tar industry, including dyes and products of chemical transformation or intermediates, amounted to \$55,264,522 distributed over 33 countries and shared in by 22 factories; on June 30, 1912, 21 of these factories had a combined capitalization of \$36,700,000 and declared and paid dividends of \$11,600,000, or 21.74 per cent. of the capitalization, for that year.

Of the 5,369 active corporations in Germany on June 30, 1912, 1,004 or 18.69 per cent. are divided into 19 groups of the chemical and allied industries. Arranged in the order of their income-producing effects these 19 groups are, in part, as follows:

	Per Cent.	No. of Corporations
Coal-tar dyes	21.74	21
Metallurgy	11.78	61
Soaps and candles	11.65	21
Glass	11.61	38
Heavy chemicals	11.51	104
Explosives	11.22	28

The remainder range between 5 per cent. and 10 per cent., except mining which is at the foot of the list with 0.51 per cent. return.

Therefore, any attempt to take away coal-tar dye business from Germany means attacking the best equipped and the best income producer of Germany's entire chemical and allied industry.

Dr. Hesse estimates as follows on the entire world production:

Germany	\$68,222,846
Great Britain	5,982,675
Switzerland	6,452,651
France	5,000,000
United States	3,750,000
	\$89,408,172

with Russia, Holland, Austria and Belgium to be added. Allowing $10,000,000 for these, which is clearly very high, it makes the absolute maximum production all over the world substantially $100,000,000.

The development of the coal-tar dye industry called for 8,062 German patents in the years 1876–1912 or 224 per year; corresponding patents have been taken out in other countries, *e. g.*, 2,432 in the United States.

But it is authoritatively said that only 1 in 100 of the German patents is a money-maker, and as a matter of fact, in the case of the 921 dyes in the world markets at the end of 1912, only 485 U. S. patents and 762 German patents were involved or 19.94 per cent. of the total U. S. and 9.46 per cent. of the total German patents. Of these 921 dyes 50 per cent. were never patented in the United States, the U. S. patents on 26 per cent. have now expired, leaving 24 per cent. still covered by existing U. S. patents and many of those expiring in 1915.

Broadly speaking, the entire coal-tar dye industry is a complicated maze and network of interlocking and interlacing products and by-products; these are great in number but, in most cases, small in volume individually. In numerous instances the very existence of the by-products was the sole directing cause for the invention of new dyes and classes of dyes.

The average annual unit gross per year of the 900 coal-tar dyes, exclusive of alizarin and indigo, all over the world outside of Germany has previously been shown to be about $41,000. Add to this fact the interlocked and interlaced dependence of intermediates and finished dyes, further that the German works have long ago fully paid for their plant, their experience and their sales organization and the result is what seems to be a complete answer why Germany controls the world's coal-tar dye market. In fact, the whole industry, taking everything into account, is just about a one-nation business. It is a business made up of a large number of small units and all units essential to success.

Germany has this business established in 33 other countries; it is evident that any country starting in now would be greatly handicapped thereby if it attempted to enter the race for the full distance.

Although Germany has relied upon Great Britain for its crudes, *i. e.*, its benzol, its toluol, its naphthalene and its anthracene up to the middle of the '90's, and perhaps later, yet England has not been able to make any headway, but on the contrary, has always lost ground. Many of these non-patented world's dyes are also non-patented in England, yet most of Great Britain's requirements of those materials have always been supplied by Germany.

The answer to the question as to why Great Britain has not succeeded against Germany can not be that Great Britain is not a nation with highly developed chemical industries. A German chemist as well equipped as any other living man to express an opinion and to compare German industries with British industries has said the following:

"To be sure, we know that several of the European countries, *e. g.*, England, are still ahead of us in many branches of the chemical industry, especially in inorganic manufacture. But in no country on earth are those branches of the chemical industry which demand versatility of thought, and particularly a large body of scientifically trained employees, so well developed as with us. Our synthetic dye, synthetic drug, and perfumery industries are foremost throughout the world, and there is probably no country in which the heads of factories are so imbued with the conviction that their employees must needs cast a glance beyond domestic boundaries."

Each one of the large chemical manufacturing countries of Europe, without exception, buys more intermediate products from Germany than it sells to Germany and all of the countries but one, namely, Switzerland, buy more dyestuffs from Germany than they sell to Germany. In other words, and broadly speaking, all the rest of the world, outside of Germany, merely assembles intermediates purchased from Germany, into finished dyes; Germany alone makes all its own intermediates; that is, Germany makes all the dye-parts and the rest of the world assembles these dye-parts into finished dyes. Needless to say, the one who controls the manufacture of dye-parts actually controls the manufacture of dyes.

Where Austria, Belgium, France, Great Britain, Italy, Russia and Switzerland singly and combined have failed, in spite of their large other chemical industries, to take away this business from Germany, the American chemist should not be blamed nor found fault with because he has not succeeded, nor should it be assumed that transplanting of the whole industry can be done at once and is a perfectly easy thing to do, as so many seem to think. The transplanting of that industry

out of Germany is an undertaking properly and fitly to be described as titanic.

Why the other countries have failed is probably due to the fact that they contributed little or nothing to the real upbuilding of the business and to its creation, for the coal-tar dye business is a *created* business; those who aided in its creation were in a position first to reap the benefits—an advantage they have no doubt earned and deserved through the effort they expended and the risks they assumed.

In 1913 Germany had for sale to foreigners $3 worth of these products as against every dollar's worth that it needed at home.

Nine hundred different dyes were on the United States markets of which one hundred were made or assembled in this country from intermediates purchased from Germany. Yet these one hundred do not seem to be enough for American dye-users. How much less than the full nine hundred will satisfy American users is known to them and to the importers; the latter can not be expected to divulge that information; if the former want substantial help from American chemical makers *they* must divulge it, no other way of ascertaining being available.

In 1909 the United States produced $3,462,436 worth of artificial dyes which are probably anilin dyes in the strict sense. Compared with Switzerland's $3,200,000 production, *i. e.*, "assembly" in 1896 this is an achievement of which Americans need not be ashamed. The wonder is not that we have not done more but that in the face of the well-organized manufacturing plants of Germany and of Germany's very much superior facilities for foreign trade, both banking and carrying, that we have done as much as we have. Blame should not be parcelled out for what American chemists have not done, but credit, which has been so far withheld, should be given for what has been done in spite of obstacles abroad and obstacles at home. The users of dyestuffs have invariably opposed any tariff enactment that would substantially encourage a domestic production of coal-tar dyes. That so many are produced in this country as are being produced is due to no cooperation of dyestuffs users but was accomplished in spite of their obstruction and if to-day the users are in serious difficulty through a lack of dye-stuffs they have their own shortsightedness to blame and can not, by any argumentation whatever, shift the blame to American chemists. With proper help and encouragement the American chemist will be able to increase the domestic production of coal-tar dyes and to inaugurate the making of intermediates; in the course of time this country may then ultimately look forward to a substantial share of the world's coal-tar dye business.

Hardly any of the valuable or useful intermediates ever were patented. A considerable number of non-German chemists have invented and patented finished dyes made from non-patented intermediates. These inventors had perfect freedom to make the needful intermediates and an *exclusive* right to make, sell and use their new dyes therefrom, yet they bought their intermediates from Germany rather than make them themselves. The patent situation is therefore, really, that Germany excelled the rest of the world in making patentable combinations from non-patented and non-patentable intermediates and further in making those non-patented and non-patentable intermediates in open competition with the rest of the world. So, from one point of view, it appears that the rest of the world, inclusive of the United States, lay back, let the Germans do all the hard work and when the rest of the world finally woke up to the value of what the Germans had accomplished they became very busy making excuses and explaining instead of making a determined, directed, united and effective attempt to recover the ground so lost. That such a recovery will require the hardest kind of work on the part of all, users, capitalists, consumers and makers alike, is self-evident and obvious and the question is: do we want to pay the price? It can be done, if the price be paid.

At the conclusion of Dr. Hesse's lecture the directors were called upon for remarks. One well qualified arose and simply quoted from Mrs. Stowe's "Old Town Folks":

> One of the characters, Sam Lawson, had gone to "meetin' house" to hear the new preacher, and returning shortly afterwards to the kitchen, where the "women folks" were preparing the meal, they inquired of him why he happened to come so soon —"surely meetin' couldn't be out."
>
> He replied: "No, meetin' isn't out, but the preacher said how by a state of natur' we were all down in a deep well, and the sides of the well were glar ice. There warn't one in ten, warn't one in one hundred, warn't one in a thousan' never get out, and yet it war the partickler duty of every one of us to get out. At that pint in the discourse, I rose and went out, thinkin' any one was welcome to my chance."

From the foregoing it will appear as if the opportunity to produce colors and other articles and products in a large way in this country, while open, are not likely to be availed of to any great extent during the existence of the present war, unless the war should last much longer than even the most pessimistic fear.

I might say, however, in this connection that I remember distinctly being told by one of the best authorities on the subject that it was absolutely impossible to manufacture Portland cement in this country and it might just as well be put aside as one of the things for which this country was not adapted. I have also heard exactly the same statement regarding soda ash and caustic soda, and yet these articles somehow or other have become rather important articles of our manufacture and for a long time we have not been obliged to call loudly for outside help.

In spite of the difficulties, however, some feeble steps have been taken here, partly, I confess, out of curiosity to learn if it were really true that our coal lacked the self respect to hold all the treasures it should possess; when, strange to relate, out came aniline oil of the best quality. What happened then is worthy of note, as it shows at least one state of affairs which it is necessary to correct if we are going to escape from the dilemma which discouraged Sam Lawson. As soon as American aniline oil was offered for sale, down went the price below cost. A tariff of 10 per cent. put upon it by Congress as a compromise between judgment and party, was immediately absorbed by the foreign makers, and the price here became lower still. You see, on the other side of the Atlantic they believe in cooperation. Here our legislators think we believe in destructive competition, and have made cooperation one of the seven deadly sins. Nothing but demonstration by the ballot box will prove the contrary. A man with his ear to the ground does not always hear the "music of the spheres." The low price of aniline oil had no relation to its cost. It was simply dumped, by agreement, to discourage the American infant. And it did.

Many devices have been suggested to encourage the coal-tar dye industry in this country, such as a high protective tariff and changes in the patent law.

The former does not seem likely to be evolved, although a good deal can be said on the side that a high tariff in these articles would either result in the establishment of the industry or else produce a considerable revenue, either end most desirable to attain. The latter is such a complex subject that it is not so clear that good results would ensue on changing the patent laws. While it is important to establish a coal-tar dye industry as far as is practicable, we must not be selfish enough to forget that there are other important industries already established, and the American people must learn more and more to consider the rights and needs of the individual in their relation to the rights and needs of all.

Another obstacle, besides the patent laws and the absence of tariff protection, to the establishment in this country of any new industry strongly intrenched abroad, is to be found in the inadequacy of the antitrust laws to protect American industry against systematic dumping of goods from abroad at prices substantially less than foreign prices with intent to injure or destroy the local industry.

Much has been done by the present Congress in the creation of a trade commission and in the statutory condemnation of certain specific practises to render those laws more efficient; but, taken as a whole, the efficiency of those laws, so complete for

domestic commerce, is quite unsatisfactory when applied to imports from abroad, and that despite the very real help to be expected from the new trade commission.

The trouble lies partly in the inherent difficulty of the subject and partly in the inadequacy or ambiguity of previous legislation. First of all, our anti-trust laws can have no extra-territorial force. Cartels and trusts that would be invalid here are lawful abroad, and in so far as these operate on their own soil, even to our detriment, the individuals concerned can with difficulty be reached so long as the acts done are lawful in the country where they are done. But these unfair practises must express themselves in imports into this country, and this implies the existence of importers or agents who must either be, or occasionally come, within the jurisdiction of our laws.

And so we find in 1894 our Congress partially legislated on this very subject, and by the anti-trust sections of the Wilson tariff law (secs. 73–77) visited upon importers who should combine in importing to restrain trade in this country all the pains and penalties of the Sherman law of 1890, namely, fines, imprisonment, forfeiture of goods in transit, triple damages, injunction and dissolution.

But this Wilson bill, which may well be deemed to be the exclusive expression of congressional purpose on this subject of imports, is confined to restraint of trade by two or more—and it does not, like the Sherman law, prohibit monopolizing, nor acts done by one person or corporation alone, nor does it prohibit unfair methods as such.

Now the unfair methods here complained of are precisely those which tend to monopoly by the destruction of competitors, and they can as well be employed by a single powerful concern as by a combination.

Viewed merely as "unfair methods," it is probable that they would not have been held by the courts to have fallen under the Sherman law so long ago as 1894; but would have been classed among those acts which the Supreme Court has lately characterized as "no more than ordinary acts of competition or the small dishonesties of trade."

But in the last few years ideas on this subject have undergone a complete change, and many methods formerly thought legitimate have passed under the ban of the law. Railway rebates are a notable example of this; and now with the legislation of this year we find legislative authority for the condemnation of unfair methods of competition generally, and notably discrimination in prices with intent to injure.

Admirable as are these provisions, there is nothing in the new statutes which extends their scope by way of amendment to the Wilson bill and to imports—and there is much to indicate the legislative intent to confine those provisions to domestic commerce alone. The word "commerce" both in the unfair methods clause (sec. 5, commission bill) and in the price discrimination clause (sec. 2, Clayton bill) is defined as commerce among the states or between this country and a foreign country, and this definition excludes the idea of its including also commerce within a foreign country.

The practises that we complain of involve commerce not in the restricted sense as defined, but a commerce that includes foreign countries as well as our own. But if these practises of foreigners and importers are nevertheless to be deemed unfair methods within the commission bill (sec. 5), the only remedy for them is an order of the trade commission to desist. They are not expressly prohibited by the act itself, nor made punishable in any way. If, however,

these practises are to be deemed price discriminations within the Clayton bill (sec. 2), which seems impossible, then the only remedy besides an order to desist is a right to sue for triple damages. The difficulty in estimating any damages at all is obvious enough in any case; especially so in the case of the destruction of a small *new* industry, and still more so in the case of an embryo industry that has never raised its head.

Even if Sec. 2 of the Clayton bill apply, we must assume that it creates a new offence not included in either the Sherman or the Wilson bills; hence that there would be no authority of law for any remedy except those alluded to as given in the act creating the offence, especially so inasmuch as the Wilson law stands out unrepealed as the sole legislative expression on the subject of imports and is silent and unamended upon the subject of price discrimination.

If this conclusion be correct (and it is almost as bad if the law be in doubt) there exists a situation where the equal protection of the laws is not extended to the importer and the domestic manufacturer alike. On the contrary, a practical license is given to the importer to do that which the citizen is forbidden to do.

The foreign manufacturer or importer seldom has any inducement to act in restraint of trade as we commonly understand it, or to monopolize competing plants in this country; quite the reverse. His object is to build his monopoly by destroying a domestic industry, and one of his most potent weapons in doing this if he be well enough intrenched is to drop prices in this country below the prices which yield him profits abroad for a long enough period to drive out American competitors; when, having the market to himself, he may raise them again.

The penalties to be invoked against the foreign manufacturer and importer as deterrents are utterly inadequate to deter them from trying it on as before. The most that they can suffer from their practises is, as we have seen, a commission's order to desist, and perhaps in some cases a suit, difficult to prove, for triple damages.

What is needed is that these people should have before their eyes the same deterrents of fine, imprisonment, forfeiture of goods, triple damages, possible injunction and dissolution, as have rendered American business men careful neither to restrain trade nor monopolize nor indulge in unfair practises. The practises here condemned in reality amount to much more than mere unfair methods of competition; they verge on an illegal attempt at monopolizing. It is of the essence of monopolizing to exclude. The legislation of 1914 does not subject unfair methods in general to the criminal features of the anti-trust laws, and this is doubtless wise. But this particular offence is in its nature monopolistic and criminal, and it is the most effective form by which the foreigner can evade our anti-trust laws and illegally injure or destroy American industry. What is needed is an amendment of the anti-trust sections of the Wilson tariff act carrying into it the prohibitions against monopolizing of the Sherman act, even when practised by one person alone, and expressly defining the practise here condemned as an act of monopolizing. The pains and penalties of the Sherman and Wilson acts would then follow on these practises as a matter of course.

At the present time, when there can be no longer any thought of procuring additional protection of new industries through the tariff, it will be rash to hope that American capital and enterprise should further

embark in any of those industries, new or unknown here, which are firmly intrenched abroad, and where, as soon as the war is over, the foreigner can return to the work of attack and destruction by the methods above mentioned.

This plan, which aims to place Americans and foreigners on the same footing here could, it seems to me, be easily and quickly enacted by the present Congress. It would put American manufacturers, including American chemists, in a position to act without having all the chances against them. Are they not entitled to at least this much?

I do not believe in hothouse development of industries for which we are not adapted; but save us from the cold-storage conditions resulting from perfect organization being arrayed against us so that our real opportunities which we are in every way qualified to enjoy are frozen to death. The little aniline-oil experiment alluded to above has come to life again, and in its small way has proved during these war times to be a godsend to our manufacturers. It is gratifying to note that it is even growing in a manner which it is hoped will be permanent. It seems too bad that it should require a dreadful war to make such a little start possible; it should have been accomplished as soon as our by-product coke ovens and fuming sulphuric acid production made it possible.

To sum up, the effects of the war on the chemical industry already established in this country are measured in general by their effects on the industries consuming chemical products. It has, however, been brought very close to us that certain industries not thoroughly established here but highly organized abroad are of tremendous importance to us. We have seen that this branch of chemical industry has been the result of marvelous ingenuity, patience, research and cooperation during the more than half century since Perkin produced the first coal-tar dye in England. One of the lessons to us which it seems to me lies near the surface, and probably one of the most important lessons this people must thoroughly learn, is that of cooperation, which has had more to do with the making of the great coal-tar chemical industry than any other one influence. We as a nation have passed our childhood and youth; we have made gigantic progress at tremendous cost of materials and possibly of moral fiber; we have come to the parting of the ways. If we continue too long as we have been going we will deserve disaster if we do not actually experience it. We know on the highest authority that "a house divided against itself must fall." The laws of the resultant of forces familiar to us all show us what would happen if we all pulled in different directions. I feel strongly that our future success as a nation lies in universal cooperation—the government and its departments with the manufacturer, the manufacturer with the workman, and all together for the country and for the world; and this cooperation must not be based solely on self-interest, but more particularly on those moral qualities which lie at the foundation of universal brotherhood. It must not be the survival of the fittest, but the survival of all, and the very best that is in them brought out of all. When we have learned and adopted this lesson of cooperation for the good of all, we have started on the road to a national greatness, both material and moral, which I modestly feel that the possessions of this people qualify it richly to enjoy.

WM. H. NICHOLS

NEW YORK, N. Y.

THE RELIEF OF OUR PACIFIC COAST[1]

Ever since the landing of the Pilgrims on Plymouth Rock and the founding of Jamestown, if not even in the Garden of Eden, "Westward Ho" has been the cry, and the inspiration of this call of the wild is well portrayed by Leutze in his famous painting at the national capitol.

"Westward the Star of Empire takes its way" is no less true to-day than two centuries ago, but from a more commercial point of view.

The near sea level transcontinental water route of the Panama Canal is in strong contrast with the bold relief of the immigrant route of the early days in wagons across the Great Plains and Rocky mountains, with the privations of the Great Basin to the ranges of the Pacific coast with luxuriant wealth of forest and field, affording the framework for the Golden Gate where the Panama-Pacific Exposition is about to celebrate the opening of the great canal.

Many a traveler will find his way from the Atlantic coast to California on that occasion, and to prepare him for the strong contrast between the surface features of the two ocean borders I have selected as my theme on this occasion "The Relief of Our Pacific Coast." It will indeed be a great relief to the generous heart of the Pacific coast to welcome a large number of visitors to the Panama-Pacific Exposition, but that is not the relief to which I refer. It is to the form of the land surface, its ups and downs with reference to the sea level along our Pacific coast, that your attention is invited. It is the subject which in one form or another has held my attention as a field of investigation in connection with the United States Geological Survey for many years. Do not be dismayed at this length of service as affording a suggestion of the duration of this discourse. But quite the contrary, the proportion should be inverse, for it seems quite probable that my eminent predecessor, Professor Lesley, was right when he declared that geologists talk too much, and I shall heed his admonition.

The backbone of the North American continent is in the Rocky Mountain system relatively near the Pacific coast. The great valley of the Mississippi lies to the east with the Appalachians and the coastal plain of the Atlantic States beyond. A 200-mile wide belt on the Atlantic coast, at least from Virginia southward, is a coastal plain and piedmont region without mountains or even big hills, but on the Pacific coast the 200-mile belt is mountainous in the extreme from Canada to Mexico.

The mountain belt of the Pacific coast is but a member of that merged group of mountain systems, the Cordilleran, that runs through the western United States and Mexico and forms the continental bond of Panama, now so happily pierced for the commerce of the world and so fittingly and attractively celebrated in the Panama-Pacific Exposition.

Indeed, it is believed that the mountain belt of our Pacific coast is no small part of the attraction to the exposition. It constitutes not only the framework of the Golden Gate, the scene of the great event, but in itself embraces some of the finest scenic features of the world among which are four national parks, the Yosemite, General Grant, Crater lake, and Mount Rainier, besides three national monuments, the Pinnacles and Cinder Cone in California, the caves of Oregon, and Mount Olympus in Washington, all districts of

[1] Address of the Vice-president and Chairman of Section of Geology and Geography, American Association for the Advancement of Science, Philadelphia meeting, December, 1914. Published with the permission of the Director of the U. S. Geological Survey.

profound geologic and geographic interest and each so distinctive as to be especially attractive.

The relief of a country may be expressed in terms of water power, and considering the rainfall the water power is proportional to the relief. From this point of view the Pacific coast relief is greatly in excess of an equal area of the Atlantic coast.

The area of the direct drainage into the ocean from the Atlantic States is approximately 284,000 square miles,[2] while that into the Pacific, not counting the Colorado River, is about one fourth greater than that of our Atlantic coast, and yet the energy represented by the Pacific drainage is more than seven times that of the Atlantic coast. By far the greater portion is undeveloped and gives some idea of the latent possibilities of the empire of our west. Attention should be called to the fact, however, that much of the Pacific coast power is in the Columbia river, of which the greater part lies east of the mountain belt, but, even excluding that portion of the Columbia, the enormous power of the mountain belt greatly exceeds that of an equal area along our Atlantic coast.

With this may be coupled also that of the production of precious metals, which are vein deposits formed as an adjunct of stresses that express themselves in relief. The production of precious metals in the mountain belt of the Pacific coast in recent years has been hundreds of times that of the Atlantic States.

The mountain-building period on the Pacific coast bordering the larger ocean may have been longer and more intense than that on the Atlantic, resulting in greater and perhaps later segregation, so that erosion has not removed the mountains, as has been the case upon the Atlantic side.

That this is not simply a matter of time, but of actual deformation and uplift, may be inferred from the enormous deposits of limestone and coal to the east, which indicate not only a region of low relief but low relief of wide extent. Strengthening the contrast in the relief of the coasts but balances the values of the mineral deposits.

PACIFIC COAST MOUNTAIN BELT

The continental feature bordering the Pacific coast of the United States is a mountainous belt of surpassing grandeur. Lying between the Great Basin platform of the interior on the east and the Pacific ocean on the west, it is the crushed and upheaved edge of the continent along the line of counter stress between the land and sea. The great upfolds of the earth's surface in that region are so young as to preserve much of the prominent form and mass resulting from the deformation.

It is remarkable for its lineal continuity, with a width ranging from 100 to 200 miles throughout a length of 2,500 miles. Some of it indeed at both the northern and southern ends is below sea level, but other portions, especially in California, Oregon and Washington, bear the highest peaks in the United States south of Alaska.

The general form of the belt is slightly sigmoid with a broad coastal curve to the west in northern California and to the east at the international boundary (49th par.), resulting from large structural features which will appear in an analysis of the members of the belt.

The general features of the belt are two lines or ranges of mountain elevations with a great valley between. For the most part the two lines of mountains appear to be parallel with each other and the coast; the Sierra Nevada and the Cascade ranges on

[2] Water Resources Paper No. 234, pp. 52–57.

the east and the coast ranges, including the Klamath mountains of California and Oregon and the Olympic mountains of Washington on the west from near the Mexican line to British Columbia. They are separated by a depression, a great valley more or less continuous from the Gulf of California and Salton Sea on the south through the Great Valley of California, the Willamette Valley of Oregon and Puget Sound to Georgian strait on the north, which it enters and follows with less definition along the coast of British Columbia to Alaska, a total distance of about 2,500 miles.

In the United States there are only three rivers, the Columbia, the Klamath and the Sacramento (including the Pit), which cut across the entire mountain belt from the interior platform to the sea, although three others, the Chehalis, Umpqua and Rogue rivers, rise on the west slope of the Cascade range and break through the coast range.

The mountain ranges which now constitute the topographic limits of the Great Valley of the Pacific coast are composed of parts that differ widely in origin, age and composition.

THE SIERRA NEVADA

The Sierra Nevada is a massive mountain block, 350 miles long and 80 miles wide, with a long gentle slope west to the Great Valley, and to the east has a short steep slope, due to faulting, that separates the rocks of the Sierra from those of the Great Basin.

The Sierra Nevada is composed of sedimentary and igneous rocks of various ages, from Silurian to Jurassic, which have been closely folded and intruded by batholithic masses of granitic rocks. The folding and intrusion have greatly altered the rocks and developed in them numerous metalliferous veins, chiefly of auriferous quartz. During a long period of erosion which washed away the mountains and reduced the country to low relief the veins gave rise to auriferous gravels, and some of the earlier of these gravels in the northern portion of the range are covered by flows of Tertiary lavas.

The southern and central portion of the range where granodiorite prevails is one great topographic block bounded on the east by a fault zone, which curving to the west around the southern end, meets the San Andreas fault of recent earthquake fame and brings the Sierra Nevada and the Coast range together. In the northern portion of the range along the eastern side of the great block, adjoining the Great Basin and suggesting its structure, there are two smaller fault blocks, one of which locally has sunk for Lake Tahoe, while the other forms the bold eastern escarpment of the range.

The Tertiary lavas of the Sierra Nevada are continuous to the northward with the great pile of volcanics in the Cascade range, beneath which the older terranes of the Sierra Nevada disappear with a strike of approximately N. 50° W. toward the Klamath mountains, about 60 miles away. Some minor faults appear in the lavas of the Lassen Peak region but major faults like those which characterize the Sierra Nevada have not yet been recognized in the Cascade range.

The faulting which limits the Sierra Nevada on the east, as emphasized recently by Ransome, has been of long duration and is still in progress, as evidenced by the many small earthquakes at points along its course. The Owens Valley earthquake of 1872 is the most notable example resulting from a fault of 10 feet.

The earthquake was widely felt, but there are many that are not felt at all under

ordinary circumstances, and yet may be clearly detected and their intensity and duration measured by a seismograph. Every earthquake indicates a change in the relative position of the rocks, however small, either horizontal or vertical or both, and consequently in the relief of the country. It may truly be said that the mountains are growing. In no other part of the United States is there as great seismic activity as along our Pacific coast, a fact which means that the mountains are not only growing, but growing faster than elsewhere in the United States. Some are growing less, others greater, and there is need, as pointed out by Lawson, of establishing bench marks on opposite sides along the faults, so that the amount and character of the change may be measured.

The transformation of the Sierra Nevada from a region of low relief to one of high relief so increased the river grades of its western slope that they have carved out deep canyons which now form the principal relief feature in the scenic attractions of the range. The Yosemite Valley is the finest example, although rivaled by that of Kern River, and is one of our most impressive and instructive national parks. This is especially the case since nature has made some of the finest trees in the region big in proportion, as if to correspond to the size of the canyon.

KLAMATH MOUNTAINS

The Klamath Mountains are an irregular half crescentic group of peaks and ridges along the coast in northwest California and southwest Oregon. The general shape is that of a saddler's knife, with the curved side to the west and the handle to the east, a little south of the center. Their greatest extent north and south is about 225 miles, with 75 to 115 miles in width. The crescentic border follows the coast for about 90 miles north from the mouth of Klamath River in California to near Rogue River in Oregon. To the northwest of the Klamath Mountains is the coast range of Oregon. To the southwest is the coast range of California, both overlapping the western curve of the Klamath Mountains along the coast. On the east lies the Rogue River Valley, Shasta Valley and Sacramento Valley bordered by the great lava field of the Cascade range.

The Klamath Mountains are composed chiefly of Carboniferous and Devonian sediments, with a large proportion of contemporaneous lava flows of rather basic types. Besides these there are large bodies of mica and hornblende schists of pre-Paleozoic age, as well as sediments and effusives belonging to the Jurassic and Triassic.

These rocks are folded, faulted and intruded by batholithic masses composed of granodiorite, gabbro and peridotitic rocks centering in a general core with aligned terminals that curve to the northeast in Oregon and southeast in California. The later sedimentary rocks of the Klamath Mountains, the Jurassic and Triassic, are richly fossiliferous in the Redding quadrangle, where they are associated with equally fossiliferous Carboniferous and Devonian strata that form the hills lying east of the Sacramento River and the railroad between Redding and Mt. Shasta. In the southern part of this exposure the Mesozoic rocks strike S. 50° E. in line with rocks of essentially the same age and position 75 miles away in the northern portion of the Sierra Nevada. To the northward in the Redding quadrangle we see these Mesozoic rocks curve to the right and strike to the northeast in the general direction of the Blue Mountains of Oregon. Now this change in the strike is not limited to the eastern portion of the Klamath Mountains

in the Redding quadrangle, but, more or less distinctly marked, it extends throughout the great stretch of the Paleozoic rocks of the whole group in both California and Oregon. Furthermore, the same curved trend is suggested by the form of the intruded masses. The mass of granodiorite between Lewiston and Igo extends southeast and widens directly toward the Sierra Nevada, where similar rocks are abundant.

While the composition and the plication of the rocks of the Klamath Mountains tend to show close relationship to the Sierra Nevada, it is only partial, and in reality the two are distinct, being separated in the first place by a wide depression probably due, as long ago pointed out by Whitney, to a fault across the trend of the range, and in the second place characterized by a series of overthrust faults quite unlike those which obtain in the Sierra Nevada.

Although the detailed structure of the Klamath Mountains has not been worked out, some of the major structures have been apprehended by Hershey and others sufficiently for consideration in this comparison of the several ranges of the Pacific coast chain.

The southwest limit of the Klamath Mountains against the coast range of California is marked by a profound thrust fault on which the highly crystalline schists of South Fork Mountain appear to have been thrust to the southwest up over the Cretaceous and Jurassic rocks toward the coast. The fault runs northwest and southeast and the hard schists give rise to a prominent long even-crested mountain ridge, one of the most conspicuous members of the Klamath Mountain group.

In Oregon a similar fault occurs through the Kerby region of Josephine County, where Devonian rocks are in effect thrust northwest toward the ocean up over those of Jurassic age. The fault runs northeast and southwest and erosion has developed prominent mountains facing the valley that lies to the northwest.

The Kerby fault if continued southwest in the same strike would intersect the South Fork Mountain fault, but, according to Hershey, before it reaches the South Fork Mountain fault it curves to the south and finally southeast so as to parallel the South Fork Mountain fault.

Farther east there is another fault belt which at the south end in California trends southeast, while at the northern end in Oregon its course is to the northeast. Like the other, it appears to be a thrust fault. Hershey has estimated the overthrust locally in one of the Klamath Mountain faults as much as a mile.

The curved thrust faults traversing the Klamath Mountains are in strong contrast with the normal faults of the Sierra Nevada. The Klamath Mountain thrust is to the westward. The downthrow of the normal faults in the Sierra Nevada is to the eastward. Thrust faulting occurs also locally in the Sierra Nevada, but at Taylorsville the thrust is to the eastward.

The Klamath Mountains are insular in character. Composed largely of Paleozoic rocks and surrounded by rocks of later age, they formed a buttress in the development of the coast ranges of California and Oregon. From the Sierra Nevada they are separated by a depression in the older rocks that extends northward beneath the Cascade range.

During a portion of the Cretaceous the Klamath Mountains were above sea level, but the gradual subsidence of the land almost or quite completely immersed them at the close of the Chico epoch, as shown by the rather widespread occurrence of fossiliferous fragments of sandstone from the Chico formation in the auriferous gravels of that region. During the early Ter-

tiary the region was a lowland of gentle relief cut down like the Sierra Nevada to a peneplain, but later it was raised as perhaps the great valley sank, and became a prominent mountain group.

THE COAST RANGE OF CALIFORNIA

The coast range of California lacks the wealth of precious metals found in the Sierra Nevada, and for that reason until recently it has not received so much attention from geologists. But the discovery of oil and its development has greatly stimulated research in that field. Only a few districts have been surveyed in detail and published, but much general reconnaissance has been done. What we know of the composition, structure and history of the range has been admirably summarized by A. C. Lawson and Ralph Arnold. Their summaries have recently been discussed in a most helpful critical way by Ransome, who is himself familiar with portions of the region.

The coast range of California, according to Lawson, extends from the Mexican boundary to near the mouth of Klamath River, with a length of about 720 miles, a width ranging from 40 to 60 miles, and a general trend of N. 30° W.

At the northern end Lawson includes the South Fork Mountain in the coast range, but it seems to me that the great fault on the western slope of South Fork Mountain is the delimiting feature and keeps the South Fork Mountain and Yallo Bally in the Klamath group.

The coast range is regarded by some, and Ransome among them, as ending on the south at the headwaters of Santa Maria River where the Tehachapi range joins the southern terminus of the coast range to the Sierra Nevada.

South of the Santa Maria River is a group of ridges including the San Rafael, Santa Barbara, Santa Ynez, San Gabriel, San Bernardino and other ranges, which, although not strictly parallel, have a general trend nearly east and west. These ranges embrace the Los Angeles country and have been most appropriately referred to by Ransome as the Sierra de Los Angeles.

The coast range throughout is composed of a succession of parallel ridges which, south from San Francisco to Santa Maria River, trend about N. 43° W., while in the northern portion of the range the trend is N. 26° W., giving an average course of N. 30° W. for this portion of the range. Everywhere the course of the ridges is more or less oblique to the coast line, which is made up of a series of zigzags that Lawson regards as probably due to faulting parallel and transverse to the ridges, thus cutting them off on the shore and affording excellent exposures of the composition and structure of the range.

The coast range of California is composed chiefly of Mesozoic and Tertiary rocks, with some that are older, as well as a considerable portion that belong to the Pleistocene. The oldest rocks are marble, quartzite, mica and hornblende schists like those of the Klamath Mountains and Sierra Nevada. They appear mainly as inclusions in the granitic rocks which form the concealed basement of the coast range and upon which was deposited unconformably the Franciscan formation, a complex succession composed in the main of strongly indurated sandstone with subordinate quantities of shale and conglomerate, a considerable part of radiolarian chert and foraminiferal limestone. In the upper part of the formation are interbedded lavas, and the whole is intruded by peridotite and basalt. A thick series (29,000 feet) of shales, sandstones and conglomerate of Cretaceous age follow unconformably on the crushed Franciscan and are succeeded by an extensive

succession of shales, sandstones and conglomerates of Tertiary and Quaternary age.

In composition the coast range is in strong contrast with the Sierra Nevada, being much the younger. There are great differences in structure also. The rocks of the coast range are folded, as Lawson points out, in rather sharp synclines and anticlines, some of which are overturned, as in the Monte Diablo region, toward the ocean and thrust faulted, but they are never so closely appressed as to indicate general and important deformation of the internal structure of the rocks affected. There has been no development of slaty cleavage or schistosity. In general, the axes of the folds are northwest-southeast, and although the minor folds may be more or less divergent, the major folds are parallel and extend for many miles. The coincidence of many of the larger valleys with a synclinal axis is very marked.

The coast range throughout is a faulted range and the faulting has had even more to do with the form of the relief than the folding. Many of the valleys are fault valleys with unsymmetrical slopes, the fault lying near the steeper slope. The faults, too, are especially interesting because of the earthquakes they produce. Faulting is still in progress, and each slip or movement along the fault plane results in a shock. The great earthquake of 1906 resulted from a slip along the San Andreas rift which has been traced for 600 miles. The movement was greatest in the neighborhood of San Francisco and chiefly horizontal instead of vertical, as is perhaps generally the case. Hundreds of faults slip and slight shocks occur in California every year, and perhaps hundreds more too gentle to attract attention.

The coast range as a whole may well be outlined by faulting. The steep bluff of the coast beneath the shallow and the deep sea is probably due to faulting, and the eastern side of the range in Tehama and Shasta Counties has a series of large sandstone dikes that evidently resulted from an earthquake, possibly in Tertiary time. Unlike the Sierra Nevada, which is mainly one great block tilted so that the streams consequent upon the tilting flow directly transverse to the range, the coast range is composed of many blocks with the main divide along the eastern edge, but the streams, instead of being wholly consequent, taking the shortest route directly to the ocean, are subsequent and follow the lines of easiest erosion along faults and folds to the sea.

According to Ransome, referring to the work of many others, the structure of the Sierra de Los Angeles appears to show a transition from a combination of folding and faulting such as is characteristic of the coast ranges to tilted block mountains, exemplified by the San Bernardino range, such as are characteristic of the Great Basin.

Much yet remains to be done before a comprehensive statement can be formulated concerning the structure of the coast ranges as a whole, but with the large corps of workers from the universities at Berkeley and Stanford and the United States Geological Survey as well as others in the field the detailed information is rapidly accumulating.

The coast route from Los Angeles to San Francisco is in the coast range throughout the entire trip and affords an excellent opportunity to observe many of its features.

THE COAST RANGE OF OREGON

If in California we have in the Pacific system two ranges, the Sierra Nevada and the coast range, which are strongly contrasted in composition, structure and age, in Oregon we have two ranges of still

greater contrast, not only in composition, structure and age, but in mode of development.

The coast range of Oregon extends from Cape Blanco in Oregon through Washington to the strait of Juan de Fuca, a distance of nearly 400 miles. At the southern end it abuts against or rather runs into the Klamath mountains without any sharp topographic termination. At the north it ends in the Olympic mountains of bold relief, reaching an altitude of 8,150 feet, but not quite reaching the height of the Klamath Mountains. South of the Columbia along its crest are Onion Peak, Saddle Mountain and Mary's Butte, of which several are volcanic.

On the whole the range is a unit but irregular and, as compared with the Sierra Nevada and coast range of California, is characterized by its lack of effect upon drainage. Although of small extent, it is cut across by four rivers, the Umpqua, Nehalen, Columbia and Chehalis.

It is composed wholly of Mesozoic and Tertiary rocks which at both ends abut against those of the Paleozoic age. The Franciscan series of sandstones, shales and cherts of Franciscan age, with serpentine and other intrusives, form a large part of the Olympics and a portion of the southern terminus of the range in Oregon, but have not been recognized in intermediate portions of the range. The same is true of the Cretaceous, especially the Upper Cretaceous, which lies with marked unconformity upon the rocks of Franciscan age and thus records the great diastrophic epoch of compression, probably about the close of the Jurassic.

The Cretaceous on the Pacific coast was a time of subsidence so profound, at least in one locality, as to result in the accumulation of 29,000 feet of deposits in a moderately shallow sea which transgressed the sinking land until it reached the base of the Sierra Nevada. In Oregon there was apparently a great embayment covering not only the northern end of the Klamath Mountains, but extending inland beyond the Cascade range to the base of the Blue Mountains. This great sinking embayment, as it were in the lee of the Klamath Mountains, the stable and insular terminus of the Sierra Nevada, is an important feature of both the Cascade and the coast ranges in Oregon. The steeper inclination of the Cretaceous strata as compared with the Eocene indicates their unconformity, and the discordance is the greater in proportion as the underlying Cretaceous is older.

The Eocene sandstones and shales, although mainly marine, are in part of fresh or brackish water accumulation and contain locally more or less important deposits of coal. They form the bulk of the coast range in Oregon and southwest Washington, and with them are associated in many places contemporaneous volcanics, for the most part basalts.

A large part of the coast range in Oregon and Washington south of the Olympics was probably not raised above the ocean before the close of the Eocene, but at that time the elevation became somewhat more pronounced, forming a low ridge which with minor oscillations admitted the Miocene sea through the gateway of the Chehalis and Columbia into the Willamette Valley.

Toward the southern end, where the Eocene contains some marine sandstones derived from the near shore of the Klamath Mountains, the coast range is gently synclinal. It presents a bold bluff with even crest to the Umpqua Valley, possibly due to a fault. Although, as a whole, the coast range of Oregon has not been subjected to as great compression as that of

California, nor cut into parallel ridges by large faults, yet in places along the coast, as at Coos Bay, the thinner bedded Eocene has been folded and compressed into a vertical position. The later intermittent uplift during the Quaternary is recorded by a series of elevated beaches cut more or less deeply on the west slope by the ocean waves.

THE CASCADE RANGE

The Cascade range is essentially a volcanic range stretching from Lassen Peak in California to Mt. Rainier in Washington, a distance of 450 miles. At both ends the lavas lap up on to the uplifted mountains of older rocks, the Sierra Nevada in California and the northern Cascades in Washington, but between these two from the Columbia River in Washington to the Pit River in California, for a distance of nearly 300 miles, the range is composed largely, if not wholly, of igneous rocks that have escaped from a great belt of volcanoes that form the range. The summit of the range is an irregular plateau strewn with many lava and cinder cones, of which each one marks the site of a volcanic orifice tributary to the upbuilding of the range.

Where best developed, as shown in the Klamath and Columbia river sections, the body of lava forming the range is on the average probably about 4,000 feet in thickness, but in the greater volcanoes like Hood, Jefferson, Mazama, Shasta and Lassen it rises to accumulations of 6 to 10,000 feet in thickness. The later foundations of the Cascade range were laid in the Oregon embayment during the Cretaceous and early Tertiary times, possibly before the ranges were distinctly outlined. The Tertiary volcanic effusions began in Oregon west of the Cascade range during the Eocene and possibly a little later in the same epoch eruptions began in the base of the Cascade range. During the later Tertiary the volcanic activity was greatest and the bulk of the range, though partly uplifted, was in equal or perhaps even greater measure upbuilt by flows of viscous andesitic lavas with much ejected material. Basalts are common and some acid lavas are known, but the great bulk of the range is andesite in strong contrast with the great lava plains east of the Cascades, where the thin basalt flows spread out horizontally like sheets of water. The change from the plain to the mountain slope at the eastern base of the Cascade range is abrupt and distinct, and due, for the most part, to the fact that the stiff viscous andesitic lavas were able to build up steep slopes while the superheated and highly liquid basalts spread out like water along the irregular mountain front.

After the close of the Tertiary the volcanic activity waned, although eruptions occurred to within the historic period and possibly even to the present day if the outbursts from the summit of Lassen Peak develop so as to involve molten material.

However that may be, there is no doubt that the Cinder Cone and its lava field 10 miles northeast of Lassen Peak resulted from one or more eruptions within a century or two. In 1843 both Baker and St. Helens were in violent eruption, ejecting large quantities of ashes, of which Fremont obtained samples collected at the time of the eruption. There is also well-attested authority that eruptions occurred on Mt Baker in 1854, 1858 and 1870. In general, however, the volcanoes of the Cascade range are considered extinct, and the upbuilding of the Cascade range completed as far as the actual accumulation of lava is concerned.

While the great altitude of the range is due chiefly to the piling up of lavas, a considerable portion is due to actual uplift, for in the Cretaceous of the Rogue River valley

marine shells now occur at the elevation of 3,000 feet which must have been elevated to that amount. The same may be said of the Eocene. It is, however, important to note that the uplifting of the Cretaceous and Eocene sediments about the close of the Tertiary was connected with the Klamath Mountains rather than that of the Cascade range.

Faulting that has played so large a rôle in the development of the Sierra Nevada and the coast range of California has not given general features to the volcanic mass of the Cascade range. Small faults are common in the lavas southeast of Lassen Peak, forming lines of bluffs and bringing the ground water to the surface in large springs, a feature which is common also in the Klamath Lake region and, as pointed out by Russell, along other portions of the range, but these small faults have no effect on the general form of the range.

Along the western base of the range in the Willamette Valley, Washburne has pointed out some features suggesting a fault, but as yet its existence is a matter of doubt. There is no great relief feature in that region that appears to have originated in faulting. Farther south in the Rogue River valley there is a regular practically conformable succession from the Cretaceous through the Tertiary sediments to the overlying lavas of the Cascade range. Small faults occur in the Eocene coal beds which dip beneath the range but the faults are connected with the local intrusion of the lavas and not of large extent connected with the uplifting of the range.

While it is evident that the lavas of the Cascade range are faulted, I think Russell has greatly overestimated the effect of the faulting as a factor in the upbuilding of e range, which, as it seems to me, is a great pile chiefly of viscous andesitic lavas from many confluent cone-capped vents, in strong contrast to the coneless basalt plains in the formation of which the high degree of fluidity in the outflowing lava was the most important factor.

THE GREAT VALLEY

Of all the relief features of our Pacific coast mountain belt the least impressive and yet the most important is the Great Valley where live by far the larger number of people, with railroads for transportation, and produce from the alluvial soil washed in from the adjacent mountain ranges the main portion not only of their own subsistence, but much for other parts of the world. The great valley extends throughout the entire mountain system, but not without interruptions, and in fact these interruptions are so marked in certain localities, as between the heads of the Sacramento and Willamette rivers, where the valley is obscured by cross folds from the Klamath Mountains, that some geologists have doubted its continuity. When these cross folds and their effect upon the great valley are clearly understood it will be recognized that the valley is the great feature of the Pacific mountain belt, with its history deeply buried in and beneath an enormous mass of sediments.

J. S. Diller

U. S. Geological Survey,
Washington, D. C.,
December 10, 1914

THE INTERNATIONAL COMMISSION ON BOUNDARY WATERS

Mr. Adolph F. Meyer, associate professor of hydraulics in the college of engineering of the University of Minnesota, has been engaged as consulting engineer for the International Joint High Commission, in connection with investigations made on boundary waters. These investigations have extended over the past two and a half years, and in this work Professor Meyer has been associated with Mr.

Arthur V. White, of the Conservation Commission of Canada. This gives the United States one consulting engineer and Great Britain a second. The work has involved extensive investigation relating to the regulation of the levels of the Lake of the Woods, and the utilization of the waters tributary to that lake. Water power and water supply, navigation, fishing and agriculture are the chief interests concerned. Minnesota is vitally interested in this investigation inasmuch as about 11,000 square miles of the drainage basin of the Lake of the Woods lie in this state.

A dam controlling the level of the Lake of the Woods is located in Canadian territory. The shores of the lake on the Canadian side, particularly in the vicinity of the dam, are very high, but on the Minnesota side the slope of the land toward the lake is only a few feet per mile.

Settlers have been complaining to the United States government that the lake has been materially raised and that much of their land is being flooded. The first complaints were made more than twenty years ago. During the wet year of 1905 renewed protests were sent to the Department of State, but all efforts at securing settlement through diplomatic channels failed, until finally, soon after the appointment of the International Joint Commission in 1910, this question of the regulation of the levels of the Lake of the Woods was referred to this commission.

The International Joint Commission is a permanent tribunal with powers of adjudication, created by treaty between Great Britain and the United States. While the work of this commission thus far has concerned primarily the use of boundary waters along the Canadian frontier, the powers conferred by the treaty are very broad and include, in fact, the decision of practically all matters of dispute between citizens of the United States and Canada, referred to this body by their respective governments.

All obstructions or diversions of boundary waters affecting the natural level or flow of such waters on either side of the line must receive the approval of this commission.

One of the important questions decided by the commission during the past year was that of the application of the power companies at Sault Ste. Marie, for approval of the obstruction, diversion and use of the waters of the St. Marys' River for the development of power. Another important question now under investigation by the commission is that of the pollution of boundary waters.

THE AMERICAN AMBULANCE HOSPITAL IN PARIS

WESTERN RESERVE UNIVERSITY is the first to respond to a suggestion made by officers of the American Ambulance Hospital in France, that leading American medical schools send to France corps of men to take charge of one of the hospital's services of 150 beds. The medical board of the American Ambulance Hospital, through Dr. Joseph Blake, has requested Dr. Crile to be the leader in the proposed plan. The expedition will be financed by the trustees and friends of the university and the Lakeside Hospital and left for France on December 30.

The American Ambulance Hospital was established by the trustees of the American Hospital at Paris almost immediately after the outbreak of hostilities. Ambassador Myron T. Herrick was actively interested in the project and the building of the Lycée Pasteur at Neuilly was secured. The present capacity of the hospital is 450 beds, divided into services of 150 beds each. The suggestion made by the medical board is that several of the leading medical schools of the United States send out staffs to take charge in succession of one of the hospital services of 150 beds, with operating rooms and equipment, for periods of three months each. According to the proposed plan the corps from the several universities would follow one another without interruption of service. The officials of the Ambulance Hospital believe that the opportunity is unrivalled for humanitarian service and for clinical experience and medical research.

Dr. du Bouchet is the executive head of the hospital and represents the institution with

the French war office. He also has one of the three services, which he directs personally. Dr. Crile will have free latitude in his own service to carry it on in any way he may desire.

The personnel of the Western Reserve University expedition includes:

Dr. George W. Crile, professor of surgery in Western Reserve University and visiting surgeon of Lakeside Hospital.

Dr. Samuel L. Ledbetter, Dr. Edward F. Kieger and Dr. LeRoy B. Sherry, now of the resident staff of Lakeside Hospital, who will act as assistant surgeons and clinical assistants.

Dr. Lyman F. Huffman, of the resident staff of Lakeside Hospital, who will act as clinical pathologist.

Dr. Charles W. Stone, assistant professor of nervous diseases in Western Reserve University and visiting neurologist of Lakeside Hospital.

Miss Agatha Hodgins and Miss Mabel L. Littleton, anesthetists.

Miss Iva B. Davidson and Miss Ruth J. Roberts, from the operating room staff of Lakeside Hospital.

Dr. Crile takes with him also, to assist in a special research, Miss Amy F. Rowland, B.S., Mt. Holyoke College, and William J. Crozier, Ph.D., fellow of the department of zoology of Harvard University.

CHARLES SEDGWICK MINOT

AT the meeting of the council of the American Association for the Advancement of Science held in Philadelphia on December 29, a minute was adopted in memory of Dr. Minot. Dr. Eliot, who was in the chair, stated that he had been associated with Dr. Minot for more than thirty years in the work of the Harvard Medical School and added a fit tribute of appreciation. The minute, which was presented by Professor Cattell and adopted by a rising vote, is as follows:

The council of the American Association for the Advancement of Science places on record its sense of irreparable loss in the death of Charles Sedgwick Minot and its appreciation of the value of his services to science, to education and to human welfare. Endowed with the best New England blood and traditions, trained there and in the schools of France and Germany, keen in intellect, wise in counsel, sure in action, sincere in friendship, he devoted his life to the advancement of science, the improvement of education, and the betterment of the agencies on which science and education depend. His contributions to embryology, anatomy and physiology gave him leadership in those sciences; his high ideals of education aided in advancing the standards of medicine in America and in placing the Harvard Medical School in its commanding position. Not only by his original researches, by his masterly books and by his fine addresses and lectures, but in countless other ways he helped his fellow-workers in science—in the construction of microtomes; in the establishment of a standard embryological collection; in the improvement of bibliographical and library methods; in the unit system of laboratory construction, followed in the beautiful buildings of the Harvard Medical School; in the early development of the Marine Biological Laboratory at Woods Hole; in the Boston Society of Natural History, of which he was president for many years and until his death; in the Wistar Institute for Anatomy and Biology; in the administration of the Elizabeth Thompson Science Fund and the Bache Fund of the National Academy of Sciences; in international relations, as when visiting professor to Germany and in the foreign publication of his books; in the editing of SCIENCE and of journals of anatomy, zoology and natural history; in the founding and the conduct of the American Society of Naturalists and the Association of the American Anatomists; in the establishment of the convocation week meetings of scientific societies; for us especially by his leading part in the work of the American Association for the Advancement of Science, of which he was secretary of section, general secretary, twice vice-president, president, a constant member of the council, at the time of his death chairman of the committee on policy. In the American Association, as elsewhere, Charles Sedgwick Minot leaves a vacant place which can never be filled. We take up our work sadly in his absence; but we know that it will in all the years to come be more fruitful for the heritage of his service.

SCIENTIFIC NOTES AND NEWS

AT the Philadelphia meeting of the American Association for the Advancement of Science Dr. W. W. Campbell, director of the Lick Observatory, was elected president for the

meetings to be held this year in San Francisco and Columbus.

Presidents of several of the scientific societies meeting in Philadelphia last week were elected as follows: The American Society of Naturalists, Dr. Frank R. Lillie, professor of embryology in the University of Chicago; Geological Society of America, Dr. E. O. Ulrich, U. S. Geological Survey; American Psychological Association, Dr. John B. Watson, professor of psychology in the Johns Hopkins University.

The American Mathematical Society, meeting in New York on January 1 and 2, elected to the presidency Professor E. W. Brown, of Yale University.

Dr. John Dewey was elected president of the American Association of University Professors which was organized in New York City on January 1 and 2.

The gold medal of the Geographical Society of Chicago has been awarded to Colonel George W. Goethals. It will be presented to him at a dinner to be given by the society on January 23.

The Austrian Academy of Sciences has given Professor Wagner v. Jauregg $1,250 for his research on the etiology of goiter; Professor Honigschmid, of Prague, $600, for his studies of the atomic weight of the radium elements, and Professor Netolitzky, of Czernowitz, $375 to continue his study of the history of foodstuffs.

Mr. E. J. Cheney, one of the assistant secretaries of the British Board of Agriculture and Fisheries, has been appointed to the office of chief agricultural adviser, and Mr. F. L. C. Floud to be an assistant secretary.

It is stated in *Nature* that Professor T. A. Jaggar, director of the Hawaiian Volcano Observatory, and a group of his assistants, had a narrow escape of their lives during a recent ascent of Mauna Loa. The volcano had become active, discharging large quantities of lava. The scientific party, while making an ascent to study the eruption, was caught in a snowstorm and nearly overwhelmed by snowslides almost in the path of the lava streams.

The well-known paleontologist, Professor Otto Jaekel, of Greifswald University, Germany, and a member of the Landwehr, was wounded in one of the battles of the Yser Canal, and is now recuperating at his home.

Dr. Lee M. Barney, formerly of Elkhart, Ill., but more recently of Miami, Fla., has been awarded damages of $41,500 from the casualty companies on account of the loss of sight from a chemical explosion which occurred while he was making experiments in his laboratory.

Professor John J. Flather, head of the department of mechanical engineering of the college of engineering of the University of Minnesota, is spending a year's leave of absence in Scotland. He has recently moved from Girvas, which is on the seashore, to Edinburgh, his address being 20 Greenhill Place.

Dr. R. R. Dinwiddie, pathologist and bacteriologist of the Arkansas University and Station, who has been connected with the institution since 1887, has resigned with the intention of retiring from active service.

Lyman Carrier, agronomist since 1907 in the Virginia College and Station, has accepted a position with the office of forage crop investigations of the Department of Agriculture, and has been succeeded by T. B. Hutcheson, associate professor in plant breeding in the University of Minnesota.

Dr. Harvey Cushing, professor of surgery in Harvard University, delivered an illustrated lecture on "The Portraits of Vesalius," on the evening of December 29 at the Army Medical School, Washington.

Professor Edward L. Nichols, of Cornell University, delivered an illustrated lecture on "Artificial Daylight," at the forty-seventh annual meeting of The Kansas Academy of Science, which was held in Topeka on December 22.

On December 11 Professor H. B. Ward, of the University of Illinois, lectured before the Washington University Chapter of the Society of the Sigma Xi on the "Homing of Fishes."

THE Geographic Society of Chicago holds a meeting on January 8, at which an illustrated lecture by Miss Dora Keen, of Philadelphia, will be given, entitled "Across Paraguay."

THE Washington Academy of Sciences held a joint meeting with the Botanical Society of Washington on January 5, to hear an illustrated lecture by Professor J. C. Bose on "The Response of Plants."

PROFESSOR C. S. SHERRINGTON, Fullerian professor of physiology at the Royal Institution, will deliver a course of six lectures at the institution on muscle in the service of nerve, during January and February.

THE Hunterian oration of the Royal College of Surgeons of England will be delivered by the president, Sir Watson Cheyne, on February 15.

MRS. WALLACE, widow of Dr. A. R. Wallace, died at Broadstone, Dorset, on December 10, after a long illness.

PROFESSOR JAMES HARVEY PETTIT, professor of soil fertility in the college of agriculture and chief of soil fertility in the experiment station of the University of Illinois, died on December 30 at Pasadena, California, where he was spending a leave of absence in the hope of benefiting his health. Dr. Pettit received his bachelor's degree at Cornell in 1900 and his doctor's degree at Göttingen in 1909. Since 1901 he had been connected with the University of Illinois. He was a member of the American Chemical Association and American Association for the Advancement of Science.

MR. W. W. ROCKHILL, known for his explorations in China and Tibet under the auspices of the Smithsonian Institution, and the author of several works on this and other Oriental subjects, has died at the age of sixty years.

DR. C. R. CRYMBLE, of University College, London, a fellow of the Chemical Society, has been killed in the war.

DR. A. VAN GEUCHTEN, professor of anatomy and neuro-pathology at Louvain University, has died at Cambridge.

M. LÉON VAILLANT, doctor of medicine and of sciences, formerly professor at the Faculté des sciences de Montpellier and honorary professor of the Museum of Natural History at Paris, has died aged eighty years.

AMONG examinations announced by the New York State Civil Service Commission, applications for which must be received by January 15, are the following: Physiological chemist, State Department of Health. Salary $1,800 to $2,500. Applicants should have a thorough knowledge of the principles of organic and physiological chemistry. They must have had at least three years' practical experience in physiological or biological chemistry. Open to men and women, non-resident and non-citizens subject to the usual rule giving preference in certification to citizens and residents of New York state.—Bacteriologist and assistant bacteriologist, State Department of Health. Two lists will be established as a result of this examination: one eligible to appointment as either bacteriologist or assistant bacteriologist at a salary of $2,000, open only to men who have the degree of doctor of medicine; the other eligible to appointment as assistant bacteriologist only at salaries ranging from $1,200 to $1,500, open to both men and women. Applicants should have a thorough knowledge of the principles of bacteriology and must have had considerable practical experience in the bacterial diagnosis of infectious diseases, and a general knowledge of clinical microscopy and of gross and histological pathology is desirable.—Assistant chemist, Agricultural Experiment Station, Geneva. Salary $1,200. There are two vacancies: For the first, candidates must be college or university graduates with special training in chemistry, including advanced analytical chemistry, analysis of agricultural materials such as fertilizers, feeds, crops, etc., together with some training in the microscopic identification of vegetable tissues with special reference to the constituents of feeds. For the second vacancy, the requirements are similar to those for the first except that training in microscopical identification is not required. Open to non-residents, subject to usual rule.—Chief surveyor, Conserva-

tion Commission. Salary $2,400. The appointee to this position must have had wide experience as a surveyor of Adirondack lands. He is called and is relied upon as an expert witness in title disputes and he must therefore have had wide experience in Adirondack surveys, including experience in running boundary lines.

A South American Expedition, which will work under the joint auspices of the Field Museum of Chicago and the New York Museum of Natural History, has sailed on the United Fruit liner *Metapan,* going first to La Paz, Bolivia. From La Paz, the party will cross the Andes by pack train, and descend into a section of Bolivia which is entirely new to the collector. The party will descend either the Beni or the Mamore Rivers, and eventually reach the Amazon by the Madeira. The party consists of Messrs. Lee Garnett Day, Alfred M. Collins, George K. Cherrie, Robert H. Becker and W. F. Walker. Mr. Day has traveled in the Orient and in Brazil. Mr. Collins during the past two years has made hunting trips in South Africa and the Arctic regions north of Siberia. Mr. Cherrie accompanied the Roosevelt expedition last season, and has collected for the British Museum, the New York Museum of Natural History and the Field Museum of Chicago. Mr. Robert H. Becker has just returned from the Amazon Valley and southern Brazil, where he collected for the Field Museum.

Dr. Frank Billings, Chicago, has been invited to deliver the Lane lecture for 1915. The *Journal* of the American Medical Association gives the list of previous lecturers, which is as follows:

1896. Sir William Macewen, regius professor of surgery, University of Glasgow. "Surgery of the Brain."

1897. Christopher Heath, professor of clinical surgery, University College, London. "Congenital Malformations, Aneurism and other Surgical Topics."

1898. Thomas Clifford Allbutt, F.R.S., regius professor of physics, University of Cambridge, England. "Diseases of the Heart."

1899. Nicholas Senn, professor of surgery, Rush Medical College, Chicago. "Topics in General Surgery."

1900. Sir Michael Foster, professor of physiology, Cambridge, England. "History of Physiology."

1901. Sir Malcolm Morris, surgeon, skin department, St. Mary's Hospital, London. "Social Aspects of Dermatology."

1902. Sir Charles B. Ball, regius professor of surgery, University of Dublin. "Diseases of the Rectum."

1903. Oscar H. Allis, Philadelphia, Pa. "Dislocations and Fractures Involving Larger Bones."

1904. William H. Welch, professor of pathology, Johns Hopkins University, Baltimore. "Infection and Immunity."

1905. Sir Patrick Manson. "Tropical Diseases."

1906. John C. McVail. "Practical Hygiene, Epidemics and Preventive Medicine."

1910. Reginald Heber Fitz, Hersey professor of theory and practise of medicine, Harvard University, Boston. "A Consideration of Some Features of the Lymphatic System."

1911. E. Fuchs, professor of ophthalmology, University of Vienna. "Importance of Ophthalmology in Its Relation to Systemic Disease."

1913. Edward Albert Schaefer, professor of physiology, University of Edinburgh. "Internal Secretion."

UNIVERSITY AND EDUCATIONAL NEWS

The sum of $2,430,000 was obtained for Wellesley College in the fourteen months just ended, according to a statement given out by the treasurer. Of this amount $430,000, including a conditional pledge of $200,000 from the General Educational Board, was raised before the fire of March 17, when College Hall was burned. The remaining $2,000,000 includes a pledge from the Rockefeller Foundation of $750,000. Only three gifts of over $10,000 have been received since last August. One of these was made but ten days ago, and was a gift from Mr. Carnegie of $95,000 for the enlargement of the library.

The Massachusetts Institute of Technology has received in gifts during the past year the sum of $400,000, besides two items wherein the institute is residuary legatee, and the amounts have not been determined. Following is the list: Bequest of Caroline L. W.

French (outright), $100,000; (residue), $100,000; Lucius Tuttle, $50,000; Nathaniel Thayer, $50,000; William Endicott (residue), $25,000; Matilda H. Crocker (outright), $20,000; (residue), $20,000; Mrs. W. A. Abbe, $10,000; gift for George Henry May scholarship, $10,000; gifts for research in a number of amounts, $10,000.

OHIO UNIVERSITY, Athens, Ohio, has just put into service its $15,000 electric light and power plant. The boiler plant was previously installed in connection with the central heating system, and the above sum covered the cost of other station equipment, underground cables connecting the station with the various buildings, and the necessary transformers. The total capacity of the plant is nearly 400 horsepower.

THE complete report of the proceedings of the First National Conference on Universities and Public Service has been printed, extending to 350 pages. Copies will be sent free to trustees and other university officers, public officials, editors and librarians. To others it will be sent at cost of publication on application to Edward A. Fitzpatrick, Box 380, Madison, Wisconsin.

H. J. PATTERSON has resigned as president of the Maryland College and Station, to take effect July 1, 1915, recommending in his letter of resignation the abolishing of the office of president and the substitution of an administrative commission consisting of a director of college work, the director of the station, and the director of extension work. This plan is under consideration by the board of trustees.

DISCUSSION AND CORRESPONDENCE

FRATERNITIES AND SCHOLARSHIP

THE communication on "Fraternities and Scholarship" published in a recent number of SCIENCE[1] touches a problem of decided interest—the relation of fraternities to the welfare of our higher institutions of learning—and one which has received much attention during the past few years, particularly in the universities and colleges of the south and west. The treatment of the question by the writer who happens to be the assistant dean for men in the University of Illinois, although presented in a very "readable" form, leaves much to be desired however from even an elementary statistical standpoint, and the reader may well hesitate as to the conclusions to be drawn from the data presented, beyond the idea that fraternities may be taught to appreciate the high grades which are assumed to represent scholarship. Perhaps the demonstration of a proposition of this nature is sufficient, for the opportunity to thus influence men separated into groups competing with one another, goes far toward justifying the existence of such groups even though they may have certain shortcomings.

While among all men students (2,600) there is an increase in the average grade from 81.1 per cent.[2] for the first semester of 1909–10 to 82.3 per cent. for the second semester of 1913–14 and among fraternity men (700) from 78.7 per cent. to 81.9 per cent. for the same period, the actual increase during the five years is less, inasmuch as average second semester grades are in every case higher than first semester grades of the same college year, a result undoubtedly due to the elimination of the poorer students at the end of the first semester. Therefore similar semesters should be compared and the gain is from 81.4 per cent. to 82.3 per cent. for all men students—relatively 1.11 per cent.—and from 79.7 per cent. to 81.7 per cent. for fraternities—relatively 2.51 per cent.

This is really a small increase to result from a five-year propaganda and when taken into consideration with other factors which may have been instrumental in bringing about the result, one might wonder as to whether the smoke denoted a fire. The plotting of graphs with relatively long ordinates often conveys a misleading impression.

For the second semester of 1910–11 to the second semester of 1913–14 there is practically no gain for the average grade of all students while fraternity students exhibit a gain ap-

[1] SCIENCE, October 16, p. 542.

[2] Approximations from the published chart.

proximating 1.7 per cent. relatively. Consequently the non-fraternity graph—which unfortunately was not published—must have tended downward. The interpretation of this result seems not to have been considered in the paper and if we accept the interpretation of the data as a whole as due to the greater interest by fraternities in grades, the downward movement of the plotted line is undoubtedly due to the transfer of men to the one group at the expense of the other group. Thus one might well regret that there were not subdivisions Alpha, Beta, Gamma, etc., in the non-fraternity group in order to see if the competition engendered would not raise the average grade of all, instead of permitting one to draw on the other for resources.

The statement is made that

> in 1909 the chapters were widely scattered up and down the scale, and in 1914 they are closely grouped around the fraternity average. This fact means undoubtedly that during the interval between these years the fraternities have intensified their attention to scholarship.

Such an opinion evidently based on the range between chapters with the maximum and minimum grades, which happens to be smaller in 1914, is of course no criterion of "scatter" as ordinary inspection should have demonstrated. Computing the coefficient of variation based on chapter units, it may be found that this has a value in 1909 of $2.44 \pm .99$ per cent. and in 1914 a value of $2.02 \pm .95$ per cent., a negligible difference.

It would have been of considerable interest to have presented data for a discussion of the possible effect the increased interest by students in their marks might have had on grading by the faculty although the latter will deny it and even charge that such a suggestion is heresy. Nevertheless it is not at all impossible that the average gain of 1.11 per cent. for all students is connected with a factor of this nature, however unconsciously the result may have been brought about.

The whole question as to the value of grades as a criterion for scholarship and efficiency in our higher institutions of learning, particularly where based on frequent examinations throughout the semester, is still an open one, although several interesting papers bearing on the subject have been published. While the individual who would normally "loaf" is thus compelled to retain bookish facts temporarily, there are others in which a distaste for a subject results from such methods. It is evident however that until the grade of instruction in our secondary schools is brought to a much higher standard, we are not in a position to adopt the plan of the German universities and require a single examination period as a preliminary to the conferring of the degree.

The publication of data relative to efficiency in college instruction is to be commended, but the interpretation of the facts will often present many difficulties. The methods of correlation are adapted to solving numerous problems in pedagogy, and it is to be hoped that not only from the University of Illinois but also from a large number of other institutions may data be presented with a clear mathematical treatment.

L. B. Walton

Kenyon College,
Gambier, O.

SENTIMENT VERSUS EDUCATION

For many years our principals, in secondary schools, have been dinning into the ears of the teachers the order to teach, not to "hear recitations." The same bureaucrats have urged the teachers to help the dull ones, letting the bright ones find their own way. It has resulted that by the time the teacher has gone through the five formal steps the bright students know enough to make a passable recitation the next day, at least if the teacher proves as "helpful" as the custom of the school requires. The dull ones know that the matter will be gone over and over again and they see no necessity to study. The teacher has displaced the text-book.

Our pupils do not secure the power to get the meaning of any passage more complex than what we find in the daily paper or popular novel. This is partly due to the fact that the teacher is ordered to use "simple language, the language of all great writers."

We have to define efficiency by "work out divided by work in." The teacher has also replaced the dictionary.

Our school work in what is called, from custom, reading seems to consist in reciting some "pieces," very ultra-modern, calling for some acting and a little thought. Later the pupils are required to learn what some critic has said about the great works, with perhaps extracts from the professor's doctorate thesis. It is then certain that the pupil will not read any of the books which he has heard called classics.

A teacher found that his pupils could not get what was in the book. They said: "Why do the books not present the matter as you do?" He wrote the book; he reported that the reviewers said that it was about as dry a book as they had ever seen.

JOHN N. JAMES

INDIANA, PA.

THE COTTON WORM MOTH

I WAS interested in Professor Fernald's note on the cotton worm moth in your issue of November 27. Professor Fernald reports that few of these moths were taken in Massachusetts in 1912. Now in 1912 we had a great flight of them here, the only invasion on a large scale that I have heard of in this locality. They were here by the tens of thousands, literally covering the ground for a space of 100 square feet or so under some of the street lights.

The moths arrived on the night of October 10; the night watchman in the village told me they came in all at once at about 3 A.M. and flew for a time in such swarms round the electric lights "that you couldn't see the lights for the moths." They were reported in large numbers in at least one other village near here; and my father who was then living in London, Ontario, wrote me that there had been an invasion there which arrived two or three days earlier than ours here, but which must have been on the same large scale as to numbers.

It would be interesting to know whether these were parts of the same front, or separate swarms moving independently.

In 1913 I saw none here, but during the past autumn there were a few specimens, though I have no record of the date of their appearance.

A. P. SAUNDERS

CLINTON, N. Y.

METEOROLOGICAL OBSERVATIONS IN GERMANY

A LETTER dated Berlin, November 30, 1914, from Professor Dr. Gustav Hellmann, director of the Royal Prussian Meteorological Institute in Berlin, advises us that the usual regular observations are being maintained without interruption throughout the German Empire. So far as the internal weather forecasts for Germany are dependent upon cable reports from foreign countries they are made with difficulty; all such reports are at present interrupted, even those from Iceland, since the latter come over a Danish cable that lands at Aberdeen where they are suppressed and are not permitted to reach even Copenhagen. The regular, though belated arrival of the *Meteorologische Zeitschrift*, together with other scientific publications show that the German scientific world is far from suspending its existence during its present struggle.

C. ABBE, JR.

SCIENTIFIC BOOKS

An Account of the Mammals and Birds of the Lower Colorado Valley, with Especial Reference to the Distributional Problems Presented. By JOSEPH GRINNELL. University of California Publications in Zoology, Vol. 12, No. 4, pp. 51–294, Pls. 3–13, 9 text figures, March 20, 1914.

The report before us gives the results of an expedition undertaken in the spring of 1910 by the California Museum of Vertebrate Zoology. Since the founding of this museum by Miss Annie M. Alexander, in 1908, Grinnell and his staff have spent much of their time in the field, accumulating extensive series of specimens, representing the fauna of California and adjacent states, and

of the coast region as far north as Alaska. This valuable material has been collected largely with a view to the study of geographic variation. Throughout that time, and indeed for a much longer period, the author of the present report has been active in describing and subdividing species of Pacific Coast birds and mammals.

A considerable proportion of the vertebrates of this region are represented in different parts of their range by different local races, for which the term "subspecies" has gained general acceptance. Indeed, the process of "splitting" in these groups has been carried to such lengths that a large majority of the birds and about three fourths of the mammals listed in the paper here considered are designated by trinomials. Outside of taxonomic circles the feeling is sometimes expressed that these trinomials stand for more or less fictitious entities, the product of minds in which the passion for detecting differences has almost reached the stage of paranoia. In quite a different spirit is Bateson's recent advice to the systematists to "subdivide their material into as many species as they can induce any responsible society or journal to publish," since "the collective species is a mere abstraction, convenient indeed for librarians and beginners, but an insidious misrepresentation of natural truth."[1] Whether these ultimate subdivisions are termed species or subspecies is, of course, a matter of secondary importance. The main thing is that they should be described and named.

It is probably no mere accident that several of the leading exponents of the "isolation" theory of specific differentiation have done much of their field work on the Pacific Coast of North America. Here the subdivision of the earth's surface by means of natural barriers is carried to an extreme probably not elsewhere found within the limits of the United States. It is true that in many cases the areas thus marked off differ very greatly in their climatic conditions, as witness the abrupt change which we encounter in crossing the mountains from the Mojave Desert to the orange belt of southern California. Any specific differences which are met with on the opposite sides of such a barrier might be attributed to environmental differences acting directly or indirectly. Such cases do not, of course, prove anything as to the efficacy of isolation *per se* in giving rise to divergent descent lines.

In the lower Colorado River, however, Grinnell finds what he regards as a critical instance. Here is a river, bordered on each side by a vast expanse of desert, uniform in its character for great distances, whether to the right or left. Considered as a physical environment, the California side of the river is identical with the Arizona side. Yet of the 23 species of rodents collected in the valley of the Colorado by the museum expedition of 1910 Grinnell and his party found 8 which were absolutely restricted to one or the other side of the river. These last were all strictly desert-dwelling forms which probably never visit the water's edge. On the other hand, the inhabitants of the lower reaches of the river bottom were found to be in every instance common to the two banks.

The case upon which the greatest stress is laid is that of two species of ground-squirrel, belonging to the genus *Ammospermophilus.* Twenty-four specimens of *A. harrisi harrisi* were captured at scattered points on the Arizona side of the river, while seventeen specimens of the closely related *A. leucurus leucurus* were taken on the California side, the two occupying the same "ecologic niche" in their respective territories. In no case was a single individual found on the "wrong" side of the river. These two species were seen at points only about 850 feet apart in a direct line. Commenting on this case, Grinnell remarks:

> The sharp separation of the ranges of [such] nearly related vertebrates by a barrier of such narrow width is, to the best of the writer's knowledge, not known elsewhere in North America.

The author makes the assumption common to both Lamarckians and Natural Selectionists that morphological differences must, in some

[1] Bateson, "Problems of Genetics," Yale University Press, 1913.

way, result from environmental differences. But, in this instance, "the climatic features (zonal and faunal, as well as associational) are identical on the two sides of the river." Therefore, it is "reasonable to presuppose separate and rather remote centers of differentiation, and convergent dispersal through time and space which brought the resulting types to the verge of the river, beyond which they were unable to spread." It is needless to point out that hypotheses exist, *e. g.*, that of "mutation," which do not invoke the aid of environmental differences to account for all specific change. According to such a view, the "remote centers of differentiation" could be dispensed with.

If, as Grinnell believes, the two sets of animals "have undoubtedly descended from ancestral lines, which have invaded the territory from the two opposite directions," already specifically distinct, we can not see the force of the conclusion that "adequate ground is afforded for the belief that intervention of barriers is a prime factor in the differentiation of species." All the evidence shows in this case is that the barrier has kept these species apart. It may have had nothing to do with their differentiation as species. Indeed, in the absence of experimental evidence, we can not even affirm with certainty that any physical barrier has been necessary for the continued maintenance of their specific distinctness. It is not impossible that a high degree of sterility would be found to exist between the California and the Arizona species. Nevertheless, the facts, as described, are of great interest. Further expeditions should be sent into the valley of the Colorado for the express purpose of testing some of these important questions. And the work should be done before nature's original scheme of distribution has become hopelessly muddled through man's agency.

Grinnell recognizes "three distinct orders of distributional behavior as regards terrestrial vertebrates." First,

every animal is believed to be limited in distribution *zonally* by greater or less degree of temperature, more particularly by that of the reproductive season. . . . When a number of animals (always in company with many plants similarly restricted) approximately agree in such limitation, they are said to occupy the same life-zone.

Throughout this and many other papers by the same author the "life-zone" conception plays a prominent rôle. The zones recognized by C. Hart Merriam are adopted by Grinnell, and their existence accepted as a fundamental datum, without the necessity of their being justified to the reader. The author believes, following Merriam, that the position and extent of these "zones" is determined by temperature conditions. Yet it is obvious that, throughout considerable portions of the continent, the details of temperature distribution are not known with any approach to precision. Thus, the actual criterion which the field zoologist falls back upon in any given case is the character of the fauna and flora which he finds associated together. The presence of certain species shows him that he chances to be in this or that "life-zone." It is assumed, though apparently seldom verified, that wherever these particular species occur in conjunction, the temperature conditions are in some essential respect similar.

It would seem *a priori* that in traveling along a uniform gradient from a region of higher to one of lower average temperature, or vice-versa, one would continually pass into and out of the ranges of species which found their limits of physiological adaptability at different points along the line. One would scarcely expect to encounter critical points, where the fauna and flora as a whole, or at least the most characteristic members of it, were suddenly replaced by a quite different assemblage. Yet this is the essence of the "life-zone" conception.

It would be foolhardy, indeed, for a zoologist of limited field experience to criticize this conception. It is doubtless based upon extensive and accurate observations and represents real facts. But unfortunately they are, in a high degree, facts which, by their very nature, are scarcely communicable to most biologists. Before the life-zone conception can be of much service to the average student of evolutionary problems it will have to be expressed in terms

which he is able to comprehend without making extended explorations, under the personal escort of one of the initiated. Until then, such expressions as "Upper Sonoran," "Transition" and the like will be to him mere empty names, or at best, they will recall to his mind certain colored areas, on a map of North America, the boundaries of which seem to have been chosen quite arbitrarily.

The second type of "distributional behavior" recognized by Grinnell is that which he terms "faunal." The various life-zones are each subdivided into a number of "faunal areas" (or, more simply, "faunas"), "on the causative basis of relative uniformity in humidity." We must, at the outset, question the wisdom of appropriating the word "fauna" for use in such a restricted and technical sense, particularly since quite a variety of meanings have already been attached to it by previous writers.

Grinnell regards it as "probable that every species is affected by both orders of geographic control" (*i. e.*, temperature and humidity), though believing the influence of temperature to be the greater of the two. While this belief in the rôle played by humidity does not appear to be based, in any single case, upon exact observational data, it would surely be unreasonable to throw it out of consideration on that account. One does not require an accurate hygrometer to sense the difference in humidity between the atmosphere of the redwood district of northwestern California and that of the Mojave Desert. We can not help wondering, however, whether sufficient care has been taken to disentangle the effects of atmospheric humidity from those of rainfall and soil humidity. Regions of high atmospheric humidity *may* be regions of high rainfall as well, but the reverse is not infrequently true, as witness the coast of southern California. It is a matter of common knowledge that vegetation is far more affected by the though the latter is also an important factor.[2] moisture of the soil than by that of the air, Since the distribution of animals is so largely conditioned by that of plants, the indirect effects of rainfall and soil humidity upon the fauna of a region are beyond doubt. With rodents and other burrowing animals it seems not unlikely that the effects are much more direct.

The third "category of distributional control" recognized by Grinnell is that which he terms "associational." By "associations" he means "tracts of relatively uniform environmental condition, including their inanimate as well as living elements." They are, of course, subdivisions of a "fauna," just as "faunas" are subdivisions of a "life-zone." The "association" proper to a species represents its habitat, in the narrower sense, as distinguished from its geographical range. It is here that we find the most conspicuous correlation of the "so-called adaptive structures of animals . . . with certain mechanical or physical features of their environment."

The associations considered in the present report are all (except one) named for some characteristic plant, and, in fact, the term itself is borrowed from the botanists, by whom this conception was first developed. Ten of these associations are distinguished in the lower Colorado Valley traversed by the expedition under consideration. This whole region, however, belongs to the "Colorado Desert Fauna" and to the "Lower Sonoran Life-Zone."

The report contains a considerable fund of valuable ecological detail, palpably based upon careful observation, and in a large degree coordinated, so as to lead to conclusions, or at least to definitely formulated problems. In this last respect it stands in gratifying contrast to the recent output of some of the professed exponents of the science of ecology. A highly interesting special instance is Grinnell's discussion of associational restriction, as illustrated by the various species of pocket-mice (*Perognathus*). Here a truly quantitative mode of treatment has been resorted to, and very instructive results reached, despite the comparatively small number of individuals.

[2] Transeau (*American Naturalist*, December, 1905) contends that the controlling influence for plants is the ratio of rainfall to evaporation.

If nothing more, they point out a promising method of detecting and measuring associational preferences among animals which may be readily trapped.

The evolutionary theories of Darwin and Wallace were largely founded upon personal observations of geographical distribution. The modern student of genetics, on the contrary, carries on his studies for the most part in the laboratory and the breeding pen. It is significant, therefore, that Bateson,[3] perhaps the foremost living Mendelian, devotes a considerable portion of a recent volume to the problems of geographic variation. And one can hardly read that volume attentively without being convinced that the field naturalist holds the key to some of the most important secrets of nature. It is not improbable, therefore, that works of the sort here reviewed will come to receive more serious consideration from those who are concerned primarily with the problems of organic evolution.

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Chemical Technology and Analysis of Oils, Fats and Waxes. By DR. J. LEWKOWITSCH. Edited by GEORGE H. WARBURTON. Vol. II. 1914. Pp. 994. $6.50.

The first volume of this work appeared in this country while the author lay dead. While the death of an eminent chemist is always to be regretted, in this case there was an additional reason for regret—the delay, or worse yet, the possible non-appearance of the remainder of the treatise. The delay has been so slight as not to be noticed and the editorial work has been most satisfactorily performed by Mr. Warburton, who for seventeen years was associated with Dr. Lewkowitsch in his analytical practise.

This volume has been increased in size by thirteen per cent.; important additions have been made in the articles on linseed, tung, soy bean, cocoanut oils and candelilla wax, as *well as minor additions to other portions to bring them thoroughly up to date.*

The work may fairly be described as monumental; nothing would seem to have escaped attention. Even the toxicity of the different chlorides with two atoms of carbon has been given, as having a bearing on their technological uses.

Notwithstanding the very full table of contents, the reviewer misses, and must wait a year perhaps for, an index which it would seem advisable to include in each volume. Similarly the reviewer is inclined to question the advisability of including the large amount of statistical matter about the commercial side. That, it would seem, might well form the subject of a single volume, like the author's "Laboratory Guide to the Fat and Oil Industry" and be revised and brought up to date more frequently. If the work continues to grow as it has in the past, it would seem worth while to consider its publication by some society, as its compeer "Beilstein" has been taken over by the German Chemical Society.

A. H. GILL

SPECIAL ARTICLES

THE NITROGEN NUTRITION OF GREEN PLANTS

IT is the teaching of botanists that green plants obtain their nitrogen chiefly in the form of nitrates, though ammonium salts may be utilized to some extent by certain plants at least. Exceptions to this general rule are those plants provided with root-tubercles (and bog plants and others which have mycorrhiza?). These plants obtain their nitrogen in the form of organic compounds made for them by the bacteria growing in the tubercles.

That nitrogen circulates throughout the structures of plants in organic combination is certain. There does not appear to be any reason why similar compounds which are soluble and diffusible (amino acids?) should not be taken up through the roots of plants and utilized as such. It appears to the writer that this must very probably be the case. Arguments in favor of this view are:

1. The nitrogen nutrition of the leguminous

[3] *Op. cit.*

plants and others with root-tubercles is of this character.

2. The close symbiosis between "Azotobacter" and similar nitrogen-absorbing bacteria and many species of algæ is well known.

3. The increased production of timothy and other grasses when sown *along with clover,* not merely following, has been demonstrated.

4. The vigorous growth of plants in soils very rich in organic matter. Such material inhibits the growth of the nitrous-nitric bacteria when grown in culture, and may do so in soil, so that nitrates may not account for this vigorous growth.

5. As a general rule the most fertile soils contain the most bacteria.

6. The doctrine that nitrates furnish the nitrogen to plants was established before the activities of bacteria in the soil were suspected and should be re-investigated under conditions absolutely controlled as to sterility. It is probably true in large part, but may not be the exclusive method.

It would seem that one of the chief functions of bacteria in the soil is to prepare soluble organic compounds of nitrogen for the use of green plants. It does not appear to be really necessary that organic nitrogen compounds decomposing in the soil must be "ammonified," "nitrited" and "nitrated," as is now generally held since Winogradsky demonstrated the activities of bacteria in these lines to account for the presence of nitrates in the soil.

Experiments have been made by various observers in growing seedling plants of different kinds in water culture with one, or in some cases, several of the amino acids as sources of nitrogen. Most of these experiments have been disappointing. Plant proteins are not so different from animal proteins, nor plant protoplasm (apart from the chlorophyl-containing portions) from animal protoplasm as to lead one to suppose that it could be built up from one or two amino acids any more than animal protoplasm can. The writer is strongly convinced from investigations on this subject for several years that it should be thoroughly investigated. It will require careful experimentation and possibly rather large funds to provide the amounts of amino acids that would probably be needed, but might result in a decided change in current ideas of soil fertility and in the use of nitrogen fertilizers.

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THE PHILADELPHIA MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE sixty-sixth meeting of the American Association for the Advancement of Science and of the affiliated national scientific societies was held in Philadelphia, December 28, 1914, to January 2, 1915. Houston Hall at the University of Pennsylvania was the headquarters and most of the meetings of the sections and affiliated societies were held in the various buildings of the university.

The registered number of members in attendance was one of the largest in the history of the association, being 1,086. The number for the affiliated societies could not be definitely ascertained. A number of institutions sent delegates to the meeting and ten foreign associates were elected for the meeting. The following affiliated societies met during the week:

American Physical Society.
The Geological Society of America.
Paleontological Society of America.
American Alpine Club.
American Society of Zoologists.
American Society of Naturalists.
American Association of Entomologists.
Entomological Society of America.
Botanical Society of America.
American Phytopathological Society.
Society for Horticultural Science.
Sullivant Moss Society.
American Microscopical Society.
American Fern Society.
American Anthropological Association.
American Folk-Lore Society.
American Psychological Association.
Southern Society for Philosophy and Psychology.
Society of American Bacteriologists.
American Federation of Teachers of the Mathematical and the Natural Sciences.

American Nature Study Society.
School Garden Association of America.
Society of Sigma Xi.

The formal opening of the association took place on Monday evening at the first general session when the meeting was called to order by the retiring president, Dr. Edmund B. Wilson. Dr. Wilson introduced the president of the meeting, Dr. Charles W. Eliot. After the welcoming address and the reply by the president, the retiring president delivered the annual address, on "Some Aspects of Progress of Modern Zoology." This meeting was followed by a reception to the members of the association and affiliated societies by Provost and Mrs. Smith in the university museum.

Two public lectures complimentary to the citizens of Philadelphia and vicinity were given during the week. The first was by Dr. Dayton C. Miller on "The Science of Musical Sounds," on Tuesday evening in the Asbury M. E. Church; the second lecture was by Dr. William H. Nichols on "The War and the Chemical Industry," on Wednesday at the same place. Both of these lectures were well attended.

The sections and affiliated societies held their meetings morning and afternoon during the week and many important papers were read.

Numerous smokers and dinners were held by the various societies. The University of Pennsylvania very generously furnished luncheon each day in the gymnasium for all of those in attendance.

The vice-presidential addresses given before the sections were as follows:

Section A: "The Object of Astronomical and Mathematical Research," by Frank Schlesinger.

Section B: "Recent Evidence for the Existence of the Nucleus Atom," by A. D. Cole.

Section C: "Theories of Fermentation," by C. L. Alsburg.

Section D: "Safety Engineering," by O. P. Hood.

Section E: "The Relief of our Pacific Coast," by J. S. Diller.

Section F: "The Research Work of the Tortugas Laboratory of the Carnegie Institution of Washington," by Alfred G. Mayer.

Section G: "The Economic Trend of Botany," by Henry C. Cowles.

Section H: "The Function and Test of Definition in Psychology," by Walter B. Pillsbury.

Section I: "The Social and Economic Value of Technological Museums," by Judson G. Wall.

Section K: "The Classification of Nervous Reactions," by Theodore Hough.

Section L: "The American Rural Schools," by P. P. Claxton.

Section M: "The Place of Research and of Publicity in the Forthcoming Country-Life Development," by L. H. Bailey.

The most important actions of the council were as follows:

The election of 256 members and 620 fellows.

The committee on policy recommended the following resolutions, which were adopted by the council.

Resolved, That the Committee on Policy shall consist of the president, the permanent secretary and nine other members, three to be elected annually. Non-attendance at the meetings for one year to constitute resignation from the committee.

Second. The following committee was elected; to serve for one year: Messrs. A. A. Noyes, R. S. Woodward and J. McKeen Cattell; to serve for two years, Messrs. D. T. McDougal, W. J. Humphreys and E. L. Nichols; to serve for three years, Messrs. H. L. Fairchild and E. C. Pickering.

Third. Dr. Stewart Paton was elected to fill the vacancy on the committee caused by the death of Dr. C. S. Minot.

Fourth. Dr. Edward S. Morse and Dr. T. C. Mendenhall were made life members of the association under the terms of the Jane M. Smith Fund.

Fifth. Herbert A. Gill was appointed as official auditor for the association.

Sixth. That all committees of the association which have not reported for two years be discontinued.

Seventh. The nomination by the sectional committee of Section I of Mr. Elmer E. Rittenhouse as a fellow and vice-president of that section was approved.

Eighth. The nomination by the sectional committee of Section D of Dr. Frederick W. Taylor as vice-president of that section was approved.

Ninth. There was voted an appropriation of

$1,800 for the salary and expenses of the associate secretary for the Pacific Coast Division for the coming year and $400 for use in an effort to increase the membership and any sum received from entrance fees in excess of $400 to be devoted to the same purpose.

Professor Pickering gave a résumé of the work of the committee on expert evidence and a report of progress on the work of the committee of one hundred on scientific research.

The following names were added to the Pacific Coast Committee:

Professor Henry Landes, University of Washington; President Enoch A. Bryan, State College of Washington; President M. A. Brannon, University of Idaho; Professor Maxwell Adams, University of Nevada; Professor Joseph F. Merrill, director of the School of Mines, University of Utah.

The following resolution from Section K was referred to the committee on policy:

Resolved, That this association establish a standing committee of five members to be known as the "Committee on the Protection of Scientific Research," that this committee from time to time prepare and publish in the name of the association such statements and resolutions as it may consider necessary in the education of the public concerning the value of animal experimentation in the advancing of the medical and biological sciences.

The two following resolutions were adopted.

Resolved, That there be authorized a finance committee of three of which the treasurer shall be a member and chairman.

Resolved, That a committee of seven be appointed on the administration of the income of the research funds of the association, the committee to be the five chairmen of the subcommittees already formed by the committee of one hundred on scientific research, namely, Messrs. E. C. Pickering, C. R. Cross, E. W. Brown, T. W. Richards and E. L. Nichols, and in addition Messrs. E. G. Conklin and R. A. Harper.

Messrs. H. C. Cowles, Henry B. Ward and Dr. Stewart Paton were elected members of the council for three years.

A minute in memory of Charles Sedgwick Minot presented by Mr. J. McKeen Cattell was adopted by a rising vote.

The council at its final meeting passed resolutions extending thanks to Provost Smith, of the University of Pennsylvania, and to all the organizations and institutions who did so much for the comfort and entertainment of the members of the association.

At the meeting of the general committee, the following officers were elected:

President: W. W. Campbell, University of California.

Vice-presidents:

Section A: A. O. Leuschner, University of California.

Section B: Frederick Slate, University of California.

Section C: W. McPherson, Ohio State University.

Section D: Bion J. Arnold, Chicago.

Section E: C. S. Prosser, Ohio State University.

Section F: V. L. Kellogg, Stanford University.

Section G: W. A. Setchell, University of California.

Section H: G. M. Stratton, University of California.

Section I: Geo. F. Kunz, New York.

Section K: F. P. Gay, University of California.

Section L: E. P. Cubberley, Stanford University.

Section M: Eugene Davenport, University of Illinois.

General Secretary: Henry Skinner, Philadelphia.

Secretary of Council: W. E. Henderson, Ohio State University.

C.-E. A. Winslow was elected secretary of Section K, to fill an unexpired term of two years.

Dr. L. O. Howard was again reelected permanent secretary for a term of five years.

The committee voted to hold the summer meeting at San Francisco, August 2 to 7, and the next winter meeting at Columbus, Ohio, from December 27, 1915, to January 1, 1916. A convocation week meeting in which all scientific societies are invited to join is recommended for New York City in 1916–17, and a meeting in 1917–18 to be held in Toronto or Pittsburgh.

E. L. WORSHAM,
General Secretary

SCIENCE

FRIDAY, JANUARY 29, 1915

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE AMERICAN ASSOCIATION OF UNIVERSITY PROFESSORS

INTRODUCTORY ADDRESS

IN calling this meeting to order, I wish first to say a few words about the services performed by the committee on organization—and I am sure none of them will think it invidious if I refer particularly to the work of the secretary, Professor Lovejoy, who has borne the heat and labor of the day more than any one else. All of its members are busy men and the work they have done is a labor of love. It is but fair to them that it should be known to all that their labors, continued for over a year, have been singularly free from a disposition on the part of any one to push a particular scheme or ride a particular hobby. If any one, perchance, has come here to-day with a fear that something is to be sprung upon the meeting, or that the committee has, as the saying goes, something up its sleeve, pray let him disabuse himself of the idea. The committee has tried to do nothing more than had to be done to bring together a representative body, without reference to factions or sections; to get matters into shape to facilitate discussion and economize time.

Doubtless we have made mistakes. But they are only such as are incident to getting a large enterprise under way, especially considering the lack of authoritative precedents to follow, and the lack of such clerical and other machinery as the organization itself will bring into being. The committee found itself between the Scylla of doing nothing definite and the Charybdis of doing so much as to forestall action that

ought to be taken only by the organization itself. So it thought its main effort should be to collect representative opinions and to secure the adhesion of a body of men large enough to represent different types of institutions, different lines of work and different sections of the country. Each member of the committee was asked to prepare two lists of names; one of men of full professorial rank in his own institution, and the other of men (of like grade) in his own subject, irrespective of institutional connection. Then these two lists were combined so as to include names found on either. To simplify the work, invitations were not sent to men in institutions represented by less than five names.

You will readily see that there was no available way for standardizing the basis of selection employed by the more than thirty men on the committee. Hence it is not only probable that there are omissions of teachers who should have been asked, but that there is inequity of distribution among different institutions and branches of learning. But I am sure that there is no inequality which can not readily be straightened out in the workings of the association itself. It should also be stated that the draft of a constitution to be submitted has not, for lack of time and because of the wide geographical distribution of the men on the committee, been authorized by the committee as a whole. This is hardly to be regretted for it reserves for each member complete freedom of action, and emphasizes the point that the chief object of its preparation is not to supply an ideal or final draft, but a definite basis for discussions to bring out and register the will of the meeting. At the same time it should be said that the draft does not represent so much the wishes of the members of the subcommittee personally as the preponderant drift of the opinions expressed in letters in reply to the circulars sent out.

As much as this I should probably have felt like saying in any case. But the committee has asked me also to speak upon the reasons for calling this assembly together. What is the proposed association for? Any proposal to increase the existing number of associations, meetings, etc., assumes a serious responsibility. The burden of proof is upon it.

We are in a period of intense and rapid growth of higher education. No minister of public education controls the growth; there is no common educational legislature to discuss and decide its proper course; no single tribunal to which moot questions may be brought. There are not even long-established traditions to guide the expansive growth. Whatever unity is found is due to the pressure of like needs, the influence of institutional imitation and rivalry, and to informal exchange of experience and ideas. These methods have accomplished great things. Within almost a single generation our higher education has undergone a transformation amounting to a revolution. And I venture to say that, in spite of the deficiencies we so freely deplore, no country has at any time accomplished more in the same number of years.

But have we not come to a time when more can be achieved by taking thought together? In the future, as in the past, progress will depend upon local efforts in response to local needs and resources. We have the advantages as well as the disadvantages of the lack of the European system of centralized control. So much the more reason for the existence of a central body of teachers, which, lacking official and administrative power, will express the opinion of the profession where it exists and foster its formation where it does not exist. I am a great believer in the power

of public opinion. In this country nothing stands against it. But to act, it must exist. To act wisely, it must be intelligently formed. To be intelligently formed, it must be the result of deliberate inquiry and discussion. It can not be developed in corners here and there; it can not be the voice of a few, however wise. It must be formed democratically; that is, cooperatively. All interests, however humble, must be heard; inquiry and conference must glean all the experiences available; decision must be based upon mutual consultation.

The need of a voluntary organization is the greater because of certain facts in the history of the American university. The rapid growth already referred to has occurred under a machinery designed for very different conditions. We are doing our educational work under methods of control developed decades ago, before anything like the existing type of university was thought of. Our official methods of fixing fundamental educational polity as well as of recruiting, appointing, promoting and dismissing teachers, are an inheritance from bygone conditions. Their lack of adaptation to the present situation is due not to sinister intent, but to the fact that they are a heritage from colonial days and provincial habits. The wonder is not that there is so much restlessness and friction, but that there is not more. A system inherently absurd in the present situation has been made workable because of the reasonableness and good will of the governors on one side and, even more, of the governed on the other.

All the more need, then, of ascertaining, precipitating in discussions and crystallizing in conclusions the educational experiences and aspirations of the scholars of the country. I confess myself unable to understand the temper of mind which anticipates the danger of what some term trades-unionism or of interference with constituted administrative authorities as a result of the formation of this organization. As to the latter: I know of few teachers who wish additional administrative work: most would be glad of relief from duties that do not seem exactly significant and that are time-consuming. But it is not expedient, in view of the trust committed to us, to maintain a state of affairs which makes difficult or impossible among college teachers the formation and expression of a public opinion based on ascertained facts. I can not imagine that existing authorities will not welcome the results of inquiries and discussion carried on by a truly representative body of teachers. To think otherwise is to dishonor both ourselves and them. The only thing which is undignified and intolerable is that teachers, individually or collectively, should indulge in carping criticism of boards of trustees when they have not thought it worth while to cultivate an enlightened educational polity among themselves nor found the means for making themselves heard. If we do not like the present situation we have nobody but ourselves to blame.

Let me add that I can think of nothing so well calculated to lift discussions of educational defects and possibilities from the plane of emotion to that of intelligence as the existence of a truly representative body of professors. The best way to put educational principles where they belong—in the atmosphere of scientific discussion—is to disentangle them from the local circumstances with which they so easily get bound up in a given institution. So to free them is already to have taken a step in their generalization. The very moment we free our perplexities from their local setting they perforce fall into a truer perspective. Passion, prejudice, partisanship, cowardice and truculence alike tend to be eliminated,

and impartial and objective considerations to come to the front. The very existence of a recognized free forum of discussion with one's fellows gathered from all parts of the country will make for sanity and steadiness quite as much as for courage.

The fear that a "trade unionism" of spirit will be cultivated is ungrounded. I have great respect for trade unions and what they accomplish. Many of the questions which have been suggested for consideration by this body have their economic aspect. Since economic conditions seriously affect the efficiency and scope of our educational work, such topics are surely legitimate ones for inquiry and report. But the term trades unionism has been used to suggest a fear that we are likely to subordinate our proper educational activities to selfish and monetary considerations. I have never heard any one suggest such a danger for the American Bar Association or the American Medical Association. Pray, are the aims of college teachers less elevated? Or is it that our position is so much less assured that any organized association must take on such a color? Are we animated by a narrower or more sordid spirit? Is there anything in the history of our body which indicates materialism of spirit, or indeed anything but an idealism which lends itself to being imposed upon rather than to propaganda in behalf of narrow trade interests? Ladies and gentlemen, I resent such insinuations. I can not believe that we are fallen so low that association for the purpose of careful investigation and discussion of common educational interests can be interpreted by any right-minded person as a rebellious and mercenary organization. If we have so fallen, something immensely more radical than the formation of this organization is the indicated remedy.

A word upon the subject of the relation of the association to academic freedom may be in place, especially as it has been mistakenly stated in the public prints that this matter is the chief cause of the formation of this organization. I do not know any college teacher who does not believe that cases of infringement may arise. I do not know any who does not hold that such infringement, when it occurs, is an attack upon the integrity of our calling. But such cases are too rare to demand or even suggest the formation of an association like this. Existing learned societies are already disposed to deal with cases of infringement as they may come to light, and in my opinion it is a matter of detail rather than of principle whether they should be dealt with by such special bodies or by a more inclusive body like this. In any case, I am confident that the topic can not be more than an incident of the activities of the association in developing professional standards, standards which will be quite as scrupulous regarding the obligations imposed by freedom as jealous for the freedom itself. The existence of publicly recognized and enforced standards would tend almost automatically to protect the freedom of the individual and to secure institutions against its abuse.

In conclusion, let me say that proposing such an association as this is to my mind but proposing to apply to our common calling the standards and ideals to which we have been trained, each in his special line of work. In his own branch, each of us recognizes how little he can do by himself; how dependent his efforts are upon cooperation and reinforcement by the work of a multitude of others. Let us cultivate a like social sense of the wide educational interests we have in common; of our dependence upon one another as institutions and as teachers. In his own specialty, each of us recognizes the need of careful study of facts before coming to a conclu-

sion. Shall we not require of ourselves a similar scientific spirit as we try to settle educational questions? A more intense consciousness of our common vocation, our common object and common destiny; and a more resolute desire to apply the methods of science, methods of inquiry and publicity, to our work in teaching—these are the things which call for the existence of organized effort. Surely we shall have the judgment, the courage and the self-sacrifice commensurate with reverence for our calling, which is none other than the discovery and diffusion of truth. No one has any illusions about what can be immediately accomplished. Let us therefore arm ourselves with patience and endurance in view of remoter issues. No one underestimates the practical difficulties in our way. But arming ourselves with the good will and mutual confidence our profession exacts of us, we shall go forward and overcome them.

JOHN DEWEY

ORGANIZATION OF THE AMERICAN ASSOCIATION OF UNIVERSITY PROFESSORS

THE meeting called for the purpose of organizing this association was held in the auditorium of the Chemists' Club, New York City, on the afternoon and evening of Friday, January 1, and the morning of Saturday, January 2, 1915. Over 250 were in attendance in the course of the three sessions. Professor John Dewey, of Columbia University, called the meeting to order and delivered an introductory address upon the purpose and possibilities of such an association, as conceived by the committee on organization, of which he had served as chairman. Nominations for the chairmanship of the meeting being called for, Professor Dewey was nominated and elected permanent chairman, and Professor Overstreet, of the College of the City of New York, recording secretary. Addresses in support of a motion to proceed to the organization of the association were made by Professors Guthe of Michigan, Thilly of Cornell, West of Princeton, Howard of Nebraska; and a letter from Professor Gildersleeve of Johns Hopkins was read. The motion was unanimously carried.

The consideration of the draft of a constitution submitted by the committee on organization was then begun. This took up most of the afternoon and evening and a part of the morning session. In order that the alternative plans of organization might receive full discussion, the meeting, in most cases, voted upon the principles involved in the several articles, rather than upon the language of the instrument. A committee was appointed to draw up the text of a provisional constitution in conformity with the action taken by the meeting, this draft to be submitted for ratification at the next annual meeting. The decisions of the gathering with respect to the principal features of the plan of organization were as follows:

1. *Name.*—After the consideration of a number of alternatives, it was voted that the name of the society be "The American Association of University Professors."

2. *Eligibility for Membership.*—It was voted that any person may be nominated for membership who holds and for ten years has held a teaching or research position in any one, or more than one, American university or college, or in a professional school of similar grade; provided, that no person not having teaching or research for his principal occupation, and no administrative officer not giving a substantial amount of instruction, shall be eligible. Nominations for membership may be made to the council by any three members of the association; nominations thus made, and ap-

proved by the council, will be voted upon at annual meetings, a two-thirds vote being required to elect. For the guidance of the council in acting upon nominations, it was voted, upon motion of Professor Janeway, that "it is the sense of this meeting that the association shall be composed of college and university teachers of recognized scholarship or scientific productivity." It was voted that all persons to whom invitations to attend the first meeting had been sent by the committee on organization may become members of the association by signifying to the secretary their desire to do so, within three months from January 1, provided that they hold positions in institutions of collegiate or university grade and that their duties are not solely administrative.

3. *Officers.*—It was voted that the officers of the association shall be a president, a vice-president, a secretary, a treasurer, and a council consisting of the foregoing and 30 additional members. The president and vice-president are to be elected by a majority vote for a term of one year; the secretary and treasurer are to hold office for three years. Thirty members of the council are to be elected for the first year, lots being drawn to determine which shall hold office for one, for two and for three years, respectively; at each subsequent annual meeting ten members of the council are to be elected by a plurality vote to hold office for three years. The council has power to arrange the program for the annual meeting and to appoint committees to investigate and report upon subjects germane to the purposes of the association. During the year 1915 the council is authorized to spend such sums out of the funds of the association as may be necessary for the business of the year, and also to defray expenses incurred in the organization of the association.

4. *Local Societies.*—The question of the formation of local societies was discussed at some length. Although the sentiment of the meeting was apparently unfavorable to this plan, the council was authorized to take the matter under consideration and to report at the next meeting upon the desirability of the formation of institutional or territorial chapters.

5. *Dues.*—The annual dues were fixed at $2.00.

The greater part of the concluding session was given up to the discussion of topics to be placed upon the program of the association for the ensuing year. The secretary of the committee on organization read a number of interestingly diverse topics suggested in writing by members not present. A paper by Professor Royce of Harvard University on "The Case of Middlebury College and the Carnegie Foundation" was read, proposing as a suitable subject the question of "the limits of standardization" in educational methods and organization, and the "standardizing" activities of extra-academic corporations. This subject, and the two following, were finally recommended to the council as the topics most suitable for examination by special committees and report during the coming year: methods of appointment and promotion; the manner in which the university teaching profession is at present recruited, with especial reference to the existing system of graduate fellowships and scholarships. Upon Professor Seligman's motion the council was also instructed to attempt to bring about a merging in a new committee of the committees already created by the economic, political science and sociological associations to deal with the subject of academic freedom, the joint committee to be authorized to investigate the subject in behalf of this association and to report at the next annual meeting.

The committee appointed to present nominations for officers for the year 1915 reported, through its chairman, Professor Tatlock, of Michigan, that in the time at its disposal it had not been able to make sufficiently well-considered nominations for more than twenty-eight places on the council. Professor H. C. Warren, of Princeton University, who was nominated for the secretaryship, declined the nomination. The following were elected: President: John Dewey, Columbia University, education; Vice-president: J. M. Coulter, University of Chicago, botany; Treasurer: J. C. Rolfe, University of Pennsylvania, Latin. Members of the council: M. Bloomfield, Hopkins, Sanskrit; E. Capps, Princeton, Greek; A. P. Carman, Illinois, physics; A. S. Cross, Yale, English; G. Dock, Washington University, St. Louis, medicine; H. D. Foster, Dartmouth, history; E. C. Franklin, Stanford, chemistry; C. M. Gayley, California, English; R. G. Harrison, Yale, zoology; W. H. Hobbs, Michigan, geology; A. R. Hohlfeld, Wisconsin, German; G. E. Howard, Nebraska, history; A. O. Lovejoy, Hopkins, philosophy; W. T. Magruder, Ohio, engineering; J. L. Meriam, Missouri, education; A. A. Michelson, Chicago, physics; W. B. Munro, Harvard, political science; A. A. Noyes, Massachusetts Institute of Technology, chemistry; E. C. Pickering, Harvard, astronomy; H. C. Warren, Princeton, psychology; R. Weeks, Columbia, Romance philology; H. S. White, Vassar, mathematics; J. H. Wigmore, Northwestern, law; W. F. Willcox, Cornell, economics. The officers elected were given power to fill the vacancies remaining in the council, and to elect a secretary to serve during the year; it was voted that, pending the election of a secretary, Professor Lovejoy, of Johns Hopkins University, be asked to continue to discharge the duties of that office.

Votes of thanks were extended to the Chemists' Club for their courtesies; to the Women's University Club for hospitalities to woman members of the profession in attendance at the meeting; and to the officers and members of the committee on organization. The meeting, notable in the history of the American universities and distinguished by the number of eminent scholars attending and by the interest and quality of its discussions, then adjourned.

It is perhaps advisable to put on record at this time the history of the steps, antecedent to this meeting, taken in the organization of the new association. The project was initiated by a communication signed by most of the full professors of the faculty of the Johns Hopkins University, which was sent, in the spring of 1913, to the members of the faculties of nine other universities, inviting the latter to consider the advisability of the formation of such a society, and to send delegates to an informal conference for discussion of the matter. A favorable response was received in all cases, and statements expressing a conviction of the desirability of the creation of some such professional association were drawn up and signed by members of the faculties of nearly all the universities addressed. The proposed conference was held at Baltimore on November 17, 1913; it was attended by 18 delegates from the following universities: Clark, Columbia, Cornell, Harvard, Johns Hopkins, Princeton, Wisconsin and Yale. The chairman of this conference, Professor Bloomfield, was authorized to appoint a committee on organization, representing the principal subjects of study and the principal universities. This committee, under the chairmanship of Professor Dewey, after prolonged discussion, decided that

it would not attempt to define the conditions of eligibility for membership, but that invitations to join in the formal organization of the association should be sent to persons of full professorial rank whose names appeared on the lists of distinguished specialists prepared for the committee in each of the principal subjects, provided that such professors were connected with institutions having five or more names upon these lists. Some 650 of those to whom these invitations were sent have thus far expressed their sympathy with the general purposes formulated in the circular of the committee on organization, and their purpose to adhere to the association.

In accordance with the action above reported, members of the university teaching profession who did not receive invitations to the New York meeting, and who desire to become members of the Association, are asked to signify that desire to any of their colleagues who are already charter members or who may become such during the period allowed for that purpose—the first three months of the present year.

A. O. Lovejoy,
Secretary

Johns Hopkins University

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SAFETY ENGINEERING[1]

The address which forms part of the duty each year of your successive chairmen might have for its unvarying subject the newest subdivision of the engineer's field, since each year seems to furnish a new title to our lengthening list of engineering specialists.

One of the late differentiations calls attention to the field of safety engineering, and I bring to your attention some phases of this work. This portion of the field of engineering can not be said to involve any radically new fact or discovery, but to be rather a new grouping of interests as a result of a change of accent among the many industrial factors. In developing any engineering design there is usually a compromise between prime factors which dominate the result and minor factors which receive less accent; so also in industrial life such prime factors as production, cost, profits, expansion, etc., have heretofore received the greater accent, while the item of safety of the employee and the public, which has always been a factor in design and in management, has oftentimes been given relatively small weight. There is a rapidly growing feeling that every industry should receive its workers each day in fit condition and should return them to their homes whole and in like fit condition. Strong accent is now being given to this idea, which has resulted in a movement of very considerable momentum, and this change in accent is finding its expression in various legislation, in workmen's compensation acts, in the whole safety movement, including the work of safety engineering. Safety engineering has for its object the elimination of industrial accidents. While the result of such an accident was borne largely by the injured individual, the prevention of accidents remained more or less of a minor factor in industrial problems, but as the industry is required to carry directly a larger share of the burden resulting from accident, the problem has become one of prime importance. Each engineer, mechanical, electrical, civil and mining, is now asked to view his work from a new angle. Guards, guides and protective devices are added where it was perfectly evident these devices should have been before, but it be-

[1] Address of the vice-president and chairman of Section D of the American Association for the Advancement of Science, Philadelphia, December 31, 1914.

comes equally evident that this is a most superficial and inadequate treatment of a subject of large proportions. Statistical information is needed as to the kind of injury and the success of preventive methods. Questions arise as to the bearing on the accident problem of nationality, general intelligence, age, temperance, fatigue, housing, lighting and a multiplicity of factors usually considered as outside of the field surveyed by the engineer. The purely engineering phase of this problem has been variously estimated as forming only 10 to 25 per cent. of the whole, the problem being more largely one of mental attitude toward the thought of safety on the part of the employee and the whole organization, but the engineer's point of view seems particularly favorable as a point of departure for exploring the whole field and reducing observations to concrete changes in equipment and management. This situation has produced the safety engineer. His work is a new grouping of studies and interests. Beside his purely engineering training he is brought close to the doctor, the chemist, the social worker, the statistician, the works diplomat, the psychologist, the labor organization, legislative limitations and the lawyer. He can no longer measure all his work directly in dollars and he looks first to a column of statistics for evidence of his profits.

In the large industrial organizations the best engineers are thus engaged, under the immediate observation of the administrative head. The excellent results which have been obtained in the reduction of accidents accounts for the enthusiasm shown by industrial safety workers and organizations.

Much of this work requires only special attention to the idea of safety as an important matter, time, patience, careful observation, and the application of obvious remedies which are already in use. The great need at this point is for standardization of method. Considerable sums are expended for protective devices and constructions which are more or less inadequate and which have to be replaced as the art develops. In fire protection and electric installation, it has been found necessary to standardize equipment and a similar need is to be met in safety methods and devices. This can be brought about by preparing standard detailed specifications covering each case or by requiring the use of approved devices, the approval to be issued by some investigative body provided for the purpose. Detailed specifications are apt to be confusing and cumbersome and lack the simplicity of an approval system. The approval of safe devices must, however, be done by some body whose decisions will command general support as being the result of careful investigation.

In the mineral industries where the government has provided an investigative bureau for the specific purpose of "increasing safety," the method of granting approval to safe devices after careful investigation is already in operation and has so far provided a list of permissible explosives, approved miners' electric lamps, explosion-proof electric motors, switches, etc. Such work must of necessity move slowly, for careful investigation requires both time and money. For the general industrial field other interests are preparing to provide a means of standardizing similar to that brought about by the underwriters' fire insurance regulations.

Much of the more obvious preventative measures can be recognized by members of any and every organization, but there is a class of investigation the need of which has become quite evident which can not be expected of the usual industrial organization. Unsafe conditions are sometimes the result

of obscure physical facts, not so readily apparent, and these cases require long and careful scientific investigation with adequate laboratory facilities. An excellent illustration of this is found in the hazard of coal-mine explosions. Such a subject is one studied with difficulty by a single industrial organization and must be referred to some agency specially equipped for investigative work involving engineering, chemistry, physics and a very considerable expenditure of funds. The mining industry presents many such problems, such as the ignition of gases and various coal dusts by explosives, by electric sparks, and static discharges, and by filaments of broken electric lamps. The permissible limits of vitiation of mine air by natural gases, oxidization of timbers, dusts and fumes and by the use of internal combustion engines for haulage; these require extensive physiological as well as field and laboratory investigation. The deterioration of vital parts of equipment by fatigue, shock and corrosion demands laboratory investigation to devise means for proper protection and inspection.

Every industry will present similar safety problems that must be studied more carefully than can be expected of the unaided industrial organization. It is this phase of safety engineering that I wish to specially emphasize.

There are several agencies that can be expected to meet in various degree this need. One of the most promising is that of cooperation between a group of members of an industry and established laboratories, federal, state or educational, which laboratories may be specially fitted by men and equipment for investigating the special problem in hand. By this method the industry furnishes funds for the work while the laboratories furnish oversight, direction and experience in similar investigations. An investigation of the causes of explosion of grain dust by a group of millers and men interested in coal-dust explosions from the Federal Bureau of Mines illustrates this method. Such cooperation between industrial organizations and investigative agencies in safety problems should be greatly extended.

Investigative work in engineering laboratories connected with educational institutions have confined their attention largely to questions of efficiency. The present increased accent on problems of safety should find a similar accent in college engineering courses. Courses in engineering design and construction could without change in hours or relative weight in the whole course give increased emphasis to questions of safety by a careful selection of illustrative problems. Many organizations require that every drawing be "checked for safety" so that each construction has been criticized from this point of view and made to conform to safety standards. The standard screw and nut which has demanded the attention of generations of budding engineers in courses in drawing and design should find a worthy running mate in the standard safety hook or guard railing or belt protection. This change of emphasis should follow also into the engineering laboratories. As an illustration, it is essential for safety that gasoline locomotives used in mines or any enclosed space shall produce exhaust gases as free from carbon monoxide as possible. The size of machine that can safely be used under any given mine condition is a function of this carbon monoxide output, and a study of the performance in this regard is of quite as much importance as a study of the capacity or economy of the engine.

State engineering experiment stations in those states which have established such institutions can also be expected to take an

increasing interest in investigations of safety problems peculiar to the industries of each state. Their function has been to investigate fundamental problems relating to the efficient use of the material resources of the state, but the change of emphasis brought about by the safety movement will make safety problems of equal moment.

Another agency for the organized study of safety problems is found in the banded casualty insurance companies, who are in a peculiarly favorable position to bring an economic pressure to bear upon the industries to install standard, adequate safety devices. They propose to offer a reduction in rates where approved safety devices are installed and the underwriters' laboratories are hereafter to test approved safety devices to reduce accident risks as well as devices for reducing fire risks.

The general government is also aiding in safety engineering, as it is the province and duty of the Federal Bureau of Mines to conduct investigations with a view to increasing safety in the mining, quarrying, metallurgical and other mineral industries. This is the first government bureau to be established with the specific object of studying industrial safety in fields other than transportation. The laboratory facilities include an equipped coal mine for the study of mine explosions, chemical and physical laboratories, and the new buildings about to be commenced include mechanical and electrical laboratories.

These numerous agencies for the careful study of safety problems, which lie just behind the field of the self-evident and in the land of the more or less obscure, will each contribute something to the motley interests of the safety engineer and will help to eliminate industrial accidents.

O. P. HOOD

U. S. BUREAU OF MINES

ISOSTASY AND RADIOACTIVITY[1]

IT is the purpose of this paper to point out some apparent discrepancies between the observations of geodesists on isostasy and the inferences which some radiologists have drawn as to the great age of certain specimens of minerals. It seems well to begin by reviewing the results of isostatic investigations in order to estimate the degree of confidence to which they are entitled; and recent advances in radiology demand similar attention.

Correlation of these widely distinct researches is possible because it happens that the emission of heat by a globe whose excess temperature is due solely to radioactivity obeys Fourier's law exactly as does that emitted by a hot but radioinactive globe.

Geology as a science is conditioned by the state of the earth's interior, and our knowledge of its constitution is now advancing. So late as the foundation of this society in 1889 the Cartesian doctrine of a fluid earth enclosed in a very rigid shell a score or two of miles in thickness was held by most geologists. We now know that the globe is solid and on the whole of great rigidity and probably divisible into at least four distinct shells each more rigid than that overlying it, that the irregularities in density and structure which are so marked at the surface extend only to a depth of something like a fiftieth of the earth's radius; that open cavities or cracks may exist at depths of 20 miles and very possibly down to the level of isostatic compensation. We know too that the earth is radioactive but that the radioactivity is superficial, reaching only to a moderate though uncertain level; we also know, however, that the earth's heat is not wholly

[1] Abstract of the presidential address before the Geological Society of America, December, 1914. The full paper is too long for oral delivery and only this abstract was read at the meeting.

of radioactive origin. More information is certainly in store for us, for Mr. Michelson is now measuring the terrestrial tides in terms of the wave-length of light, while methods have been developed by which the distribution of density above the level of isostatic compensation can be studied.

Thus the future is full of hope. The rational method of attaining it is to make trial hypotheses, and to devise methods of testing them.

Laplace seems to have been the first to grasp the problem of isostasy and in 1818 he maintained that the irregularities of the earth and the causes which disturb its surface extend to but a small depth. I do not find in his memoirs any rigorous proof of this interesting anticipation. Sir John Herschel in 1833 regarded the earth as a yielding mass and considered erosion and deposition as the primum mobile of geology, but he did not pursue the subject. Archdeacon Pratt in 1858 first expressed the hypothesis of isostasy in exact terms, discussing it mathematically and adducing evidence in its favor from the geodetic survey of India.

As we all know, the enormous labor needful to prove the hypothesis from deflections of the vertical was undertaken by Mr. John F. Hayford. Mr. Helmert characterized Hayford's investigation as "truly magnificent" and called the underlying idea the Pratt-Hayford hypothesis.

Helmert himself devised a method of testing isostasy by observations on the intensity of gravity instead of deflections. His results coincide almost exactly with Hayford's and thus immensely strengthen the theory. At Helmert's suggestion also Mr. O. Hecker made many observations on the intensity of gravity at sea. These observations are indeed of inferior accuracy, but suffice to prove that isostatic compensation exists beneath the Atlantic and the Pacific as well as under the United States.

In my opinion the geodetic evidence for isostasy is so manifold and so consistent as to amount to proof. Equilibrium is nearly or quite complete at a depth of between 110 and 140 kilometers, the most probable value being near 120 kilometers.

Messrs. Hayford and Bowie have also investigated the effect of isostasy on the intensity of gravity in the United States and at selected stations in other parts of the world. This research confirms the existence of isostasy, but reveals certain anomalies due either to imperfect compensation some 120 kilometers from the surface or to irregularities in the distribution of density, or to both causes.

It is shown in my paper that the largest deflections in the United States and also the largest anomalies could be accounted for by a spherical batholith, say of peridotite, just buried beneath the surface and having a diameter of 8½ miles. Of course such a batholith would not be considered surprising by geologists. When the existence and abundance of dikes, sills and laccoliths at all accessible levels is considered, as well as the probability of their prevalence at all levels above the deepest volcanic foci, it appears that heterogeneities in the earth's outer shell are of the order of magnitude needful to account for the gravity anomalies. In short there is much evidence for the conclusion that compensation at the compensation level is very nearly complete.

If so, the mass beneath that level must be almost free from strain and can have cooled but little from its primeval temperature.

On the isostatic theory the continents stand out above the bottom of the ocean because of inferior density. This inferiority may be due to higher temperature or to voids such as joints, or to both. A third possibility is that it might be due to lithological differences, but of that there is no

evidence. The sub-continental temperature is comparatively high; for the thermometric gradient shows that at the level of average sea bottom the rocks below the continents have a temperature of about 100°, while at the bottom of the sea the thermometer stands near zero. As for crushing and jointing, recent experiments in my laboratory show that the volume of a brittle substance such as sulphur, confined in a brass tube, may be increased to the extent of more than six per cent. by bending the tube. There can be no question that rocks would behave in much the same way under such confinement as that to which deep-seated rocks are subject.

If the average subcontinental mass down to the compensation level had 3 per cent. more voids than the sub-oceanic mass, this would account for the present mean elevation of the land. The same result would follow if the average temperature under the continents were 40° higher than under the ocean. Or again, the combination of 20° excess of temperature and 1½ per cent. excess of voids would account for the continents.

If the areas occupied by the continents were originally bounded by the same level surface as the ocean bottoms, but possessed a smaller conductivity, so that they cooled more slowly, then it can be shown that the earth would constitute an imperfect heat engine and that abundant energy would be available for crumpling and crushing of the rocks or for the elevation of the continents.

Passing now to the recent developments of radiology, that wonderful branch of physics has very recently developed fresh surprises. Rutherford has put forward a nuclear theory of the atom, and van den Broek has shown that the place of an element in the periodic table is determined not by its atomic weight, but by the number of positive electric charges carried by the nucleus. This number of charges is known as the atomic number.

Now comes the astounding feature of the subject. It has been definitely discovered by Mr. Soddy, Sir Ernest Rutherford and others that a single atomic number may be borne by each of several substances which may have different atomic weights and, in the case of radioactive substances, different stabilities, but which are inseparable by ordinary chemical or physical properties. They display the same chemical reactions, the same electrochemical behavior, the same spectrum, the same volatility. It would appear, according to Rutherford, that the charge on the nucleus is the fundamental constant which determines the physical and chemical properties of the atom. Soddy calls the members of a group of elements bearing a single atomic number and occupying therefore a single place in the periodic table "isotopes."

So far as lead is concerned, this revolutionary doctrine has been authoritatively confirmed by T. W. Richards, who actually finds the atomic weight of lead from uraninite deposits unmistakably lower than that of ordinary lead.

The discovery of isotopism sufficiently explains the great discrepancies in the ages of minerals as computed from the uranium-helium ratio and the uranium-lead ratio. These ratios also no longer seem adapted to age determinations. It seems very possible, however, that the growing knowledge of atomic structure may eventually lead to trustworthy methods of age determination from radioactive phenomena; but in the meantime other methods must be resorted to.

If the earth has cooled externally from a high temperature, there must be a certain level at which the temperature of the rock most closely approaches the melting point at the prevailing pressure. This may

be called the eutectic level because the additional temperature necessary to fusion would there be a minimum. The question then arises what relation may be supposed to exist between the eutectic level and the level of compensation.

In computing the temperature distribution of a cooling globe which owes a part of its heat to compression, or to initial temperature, and another part to radioactivity, it is necessary to proceed by trial and error, or to test various assumptions and consider which best fits the facts. I have assumed various ages and computed other conditions corresponding to the actual heat emission of the globe. These other conditions are the depth of the eutectic level, the thickness of the radioactive shell (supposed uniform) and the proportion of the surface gradient due to radioactivity. Two cases are of special interest, the assumed ages being 68 million years and 1,314 million years.

For the lower age the eutectic level is at a depth of 121 kilometers, and thus coincides with Hayford's compensation level, the radioactive layer is 2.58 kilometers thick and radioactivity supplies 1/7 of the surface gradient or of the earth's heat emission. For an earth 1,314 million years old the eutectic level lies at 300 kilometers, the radioactive layer is 12 kilometers thick and just 2/3 of the surface gradient is due to radioactivity. In this ancient earth the highest temperature excess due to radioactivity would be found at and below the bottom of the active layer and would amount to only 106°. This is not much in comparison with the temperature of lavas and, if this age is the highest worth considering, most of the earth's heat must be due to compression.

So great an age as 1,314 million years seems incompatible with other features of the problem. This age implies that a thick shell extending from the compensation level downward to and beyond the eutectic level, a shell more than 200 kilometers in thickness, has cooled after solidification through an average temperature interval of about 600°. Now the geodesists have shown that at the compensation level the strains must be small, and I have given reason for believing these strains even smaller than those computed by the geodesists. But I hold it impossible that a layer of rock 200 kilometers thick can cool 600° without setting up large strains.

On the other hand, no such difficulty arises in the case of an earth 68 million years old, for it is easy to show that only a very small amount of cooling has occurred below its eutectic level. Furthermore, in this case the level of compensation acquires a definite and intelligible physical interpretation. Local fusion would bring about compensation. Where, then, should we look for compensation if not at the eutectic level?

In such speculations as this some latitude must be allowed. If, as the geodesists suspect it may be, the compensation level is as deep as 140 kilometers, and if this is also the eutectic level, the earth is 100 million years old, the radioactive layer is 4.74 kilometers thick and 26 per cent. of the heat emitted by the earth is of radioactive origin.

It has often been asserted that the discovery of radioactivity indefinitely prolongs the probable age of the earth. To me it seems that the determination of the level of compensation limits both the age of the earth and the amount of radioactive matter in its outer shell.

George F. Becker
U. S. Geological Survey

THE CONSTITUTION OF THE ATOM[1]

The subject of the constitution of the atom has come into extreme prominence—great ad-

[1] From the address of the president of the Royal Society, Sir William Crookes, at the anniversary meeting on November 30, and printed in *Nature.*

vances have been made—while much light has been thrown on the ultimate structure of matter. Years ago, during the persistent and systematic fractionation of yttrium, I explained that I had succeeded in separating the atoms of the so-called elements into groups; these groups undoubtedly exhibited different phosphorescent spectra and presumably had different atomic weights—although from the chemical point of view all the groups behaved similarly. I concluded that, of the lines and bands of the compound spectrum of an element, some are furnished by certain atoms and some by others. I pointed out that this was not likely to be an isolated case; that probably in all so-called elements the whole spectrum does not come from all the atoms—that different spectral rays come from different atoms, which may be interpreted to mean that there are definite differences in the internal motions of the several groups of which the atoms of a chemical element consist. I ventured to suggest a possible explanation of these facts, based on the assumption that acting on the original *protyle* were two forces—one of the character of time, accompanied by a lowering of temperature, while the other, swinging to and fro like a pendulum, and having periodic cycles of ebb and flow, rest and activity, would be intimately connected with the force of electricity. I arrived at a presentation of the elements on a lemniscate path which seemed to me to throw some light on the question of their genesis. My researches seemed to show that the persistence of the ultimate character, the eternal self-existence, the fortuitous origin of the chemical elements, could no longer be regarded merely as probable.

Apparently bodies exist which possess close upon the same atomic weights and combine in definite proportions with other substances and yet exhibit certain minute differences. For these substances, which are capable of being isolated and identified, I suggested the name "meta-elements." Thus there appears to me to be a gradation of molecules of different ranks between the atom and the compound—and these aggregations of atoms in certain circumstances might well pass for simple elementary bodies.

In recent years the old idea of the ultimate atom as a solid particle, spherical or otherwise, has slowly, almost imperceptibly, given way to the more rational conception of a minute planetary or "Saturnian" system of dazzling complexity; the conception is many-minded, aided here and there by facts that failed to fall in with the old lines of thought. Among the most prominent men through which the new conception has come to light, we have Kelvin, Stoney, Thomson, and, more recently, headed by Sir Ernest Rutherford, a host of vigorous workers in the new science of radioactivity, who have built up a conception of atomic physics often "hard to be understood," but that probably is a move in the right direction. Sir Ernest Rutherford supposes the atom to be composed of a nuclear positive charge, exceedingly small compared with the sphere of action of the atom, and consisting of a number of unit charges. Surrounding this nucleus is an external shell in which a number of separate negative electrons are distributed. Professor Soddy—whose name is closely associated with that of Sir Ernest Rutherford—is one of the earliest workers in radioactivity, and has developed a theory of the chemistry of the radio-elements based upon the periodic law and a modified form of lemniscate spiral where the existence of *pseudo*-elements having slightly different atomic weight but identical chemical properties are set out. These "isotopic" elements occupy the same place in the periodic table. He has thus arrived, by a totally different path from the one I traveled, at the conception of an element having atoms of different weight though chemically identical. The theory has recently received some confirmation by the analyses of the lead that is found in the minerals pitchblende, thorianite, etc. In my own laboratory a spectroscopic examination of the lead from Cornwall pitchblende has shown traces of thallium not found in pure assay lead; the unexpected presence of this element may have some bearing on the slightly different atomic weight values recorded for the lead extracted from the radio-minerals.

Without risking a charge of being unduly optimistic I think I may believe we are on the

brink of striking developments in our knowledge of the structure of the elusive atom. Whatever may be the outcome of researches now prosecuted with so much zeal and success, I feel that Addison was speaking with the voice of prophetic truth when, more than a hundred years ago, he said:

> Every atom is a standing miracle and endowed with such qualities as could not be impressed upon it by a Power and a Wisdom less than infinite.

SCIENTIFIC NOTES AND NEWS

The colleagues of Professor Theobald Smith on account of the impending severance of his connection with Harvard University after a service of twenty years to become a member of the Rockefeller Institute of Medical Research, are arranging to present a bas-relief of Professor Smith to the medical school and reductions of this will be made and presented to each donor of $10 or more to the fund. A complimentary dinner will be given to Professor Smith on April 17.

A "Gorgas Medal" to be given yearly in honor of Surgeon-General Gorgas has been established by the medical reserve corps, U. S. army, New York state division. This medal is open to competition to members of the medical corps of the United States army, to medical reserve corps of the army and to members of the medical corps of the organized militia. Officers may submit papers on any subject of a medico-military nature.

The Cornell Society of Civil Engineers held on January 22 in New York City its tenth annual dinner and reunion. The chief guest was Professor Charles D. Marx, of Leland Stanford Junior University, who has recently been elected president of the American Society of Civil Engineers.

Dr. J. Scott Keltie, secretary of the Royal Geographical Society, has been awarded the Cullum gold medal of the American Geographical Society.

The Academy of Natural Sciences of Philadelphia has elected as correspondents Frank Dawson Adams, of Montreal, and Alfred Werner, of Zurich.

Dr. H. E. Robertson, of the University of Minnesota, is working in Professor Aschoff's laboratory and clinic at Freiburg, Baden. He reports himself as the only foreign student at present in attendance. The staff of over thirty members has been reduced to five and the number of students from 130 to 40.

Three physicians of forty who took the recent civil service examination for the position of director of public health education, in the city of New York, have been placed on the eligible list, and President Henry Moskowitz of the municipal commission is reported to have said that an appointment will be made within a few days by Health Commissioner Goldwater. The eligible candidates are: Dr. Ira S. Wile, Dr. Winthrop Talbot and Dr. Charles F. Bolduan.

The Fenger Fellowship of $600 for 1915 has been assigned to Dr. George L. Mathers, of the resident staff of the Cook County Hospital, Chicago, who will carry on work on certain bacteriological problems in pneumonia.

Mr. George P. Vanier, of Steelton, Pa., has been awarded a certificate of merit by The Franklin Institute, Philadelphia, Pa., for his potash bulb. This bulb has been particularly designed for use in the determination, in industrial laboratories, of the total carbon in iron or steel. Mr. Vanier is chief chemist of the Pennsylvania Steel Co., Steelton, Pa. He has also designed zinc tubes and sulphuric acid bulbs for use in connection with the Vanier combustion train for the determination of carbon in steel by the direct combustion method with the electric furnace.

Professor Arthur Keith, conservator of the museum at the Royal College of Surgeons of England, will deliver, during the latter part of March, a course of five lectures on the bearing of recent discoveries on our conception of the evolution and antiquity of man.

Colonel George W. Goethals, who has been appointed Stafford Little lecturer on public affairs at Princeton University for this year, delivered an illustrated lecture on the Panama Canal at Princeton on Wednesday evening, January 27, in Alexander Hall. Owing to the

difficulty in arranging satisfactory dates, there will be only one Stafford Little lecture this year, instead of the usual two. The lecture will be published by the Princeton University Press in the Stafford Little lecture series, the former volumes in the series being by Grover Cleveland, Joseph H. Choate, Elihu Root and J. G. Schurman.

AT the Founder's Day celebration of Clark University on February 1 the speaker will be Dr. R. S. Lillie, professor of biology in the university. His subject is "The Relation of Universities to Investigation."

ON the return from his recent journey west, Dr. Ales Hrdlička, of the U. S. National Museum, lectured, under the auspices of the Archeological Institute, on "The Origin and Antiquity of the American Indian," and on "Evolution of Man in the Light of Recent Discoveries," at San Diego, Los Angeles, Stanford, Berkeley, San Francisco, Denver, Colorado Springs and Pueblo.

PROFESSOR CLARA A. BLISS, of the department of chemistry of Wells College, is on leave of absence for a second year and is studying at Columbia University. Dr. Minnie A. Graham continues as acting professor during Miss Bliss's absence.

MR. N. C. NELSON, of the American Museum of Natural History, has returned from several months' archeological field work in New Mexico, where his work was a continuation of that of previous years on the ancient villages of the Tanos, south of Santa Fé.

ACCORDING to daily papers Mr. Burt M. McConnell, who was secretary to Stefansson, the explorer, and meteorologist of the Canadian Arctic expedition is seeking to induce either the United States government or private citizens to send two hydro-aeroplanes into the far north to search for the explorer, who has not been heard from in over a year. Mr. McConnell has returned from Ottawa, where he tried to interest the Naval Service Department in the project. He was told that nothing could be done at this time. The belief in Canada is that Stefansson and his two companions, Anderson and Storkerson, are still alive and doing the work planned.

THE city of Philadelphia, acting on the recommendation of The Franklin Institute, Philadelphia, Pa., has awarded the John Scott legacy medal and premium to Dr. Charles Edward Guillaume, of Sèvres, France, for his alloy invar. This alloy contains approximately 63.8 per cent. iron and 36.2 per cent. nickel. It is characterized by possessing an extremely small coefficient of linear expansion, about 0.0000004 per degree Centigrade. Within the limits of atmospheric temperature change, its expansion is very exactly proportional to the temperature. It has a modulus of elasticity of about two thirds that of steel, and its hardness is greater than that of hard brass. Invar has found a wide application in metrology and horology. In the former, it is particularly useful for secondary standards of length, and in the latter it is employed for pendulum rods, compensating devices for torsion pendulums and balance wheels correcting the secondary error of temperature in chronometers. Dr. Guillaume has done a large amount of research work in connection with iron-nickel alloys, in the course of which he also discovered platinite.

PROFESSOR LEWIS LINDSAY DYCHE, professor of systematic zoology and taxidermy and curator of birds and mammals in the University of Kansas, died on January 20, at the age of fifty-eight years.

DR. DUDLEY PETER ALLEN, professor of principles of surgery in the medical department of Western Reserve University, Cleveland, for many years, and later emeritus professor, died on January 6, at the age of sixty-two years.

MR. THOMAS BRYANT, a distinguished British surgeon, has died at the age of eighty-six years. He retired from the surgical staff of Guy's Hospital in 1888, delivered the Hunterian oration in 1893 and served as president of the Royal College of Surgeons of England from 1896 to 1899.

SURGEON-GENERAL WILLIAM HENRY MCNAMARA, of the British army, died on January 9, at the age of seventy years.

THE death is announced, at seventy-one years of age, of Lieut.-Col. D. D. Cunningham,

F.R.S., formerly professor of physiology in the Medical College, Calcutta.

At the meeting of the Entomological Society of France on November 11, the president announced the death at the front of Léon Garreta and Jean Chatanay, two lieutenants of the reserve and members of the society. The president also announced that it has been decided to place a tablet in the library upon which shall be engraved the names of members of the society who have fallen and may fall during the war. He also announced that Captain A. Magdelaine and Messrs. J. de Muizon and J. Surcouf, also members, had been wounded but were convalescent, while J. Hervé-Bazin was in the hospital with typhoid fever. All of these men are known to American entomologists through their writings.

The following resolution was unanimously adopted at the annual meeting of the Federation of American Societies for Experimental Biology held in St. Louis, on December 28:

Whereas, Various of the European nations with which many of our members are related by birth, descent or intellectual friendship are now at war,

Resolved, That we extend to the scientific men within these nations the hope of an early and enduring peace, which will leave the nations with no permanent cause of rancor towards each other, and which will insure to each the glories of scientific and humanitarian achievement in accordance with its own conception of these ideals.

The Society of American Bacteriologists held its annual meeting in Philadelphia at the Laboratory of Hygiene, University of Pennsylvania, December 29, 30 and 31, 1914. The following officers were elected:

President: D. H. Bergey.

Vice-president: John Weinzirl.

Secretary-Treasurer: A. Parker Hitchens.

Council: K. F. Kellerman, W. A. Stocking, Jr., R. E. Buchanan and H. J. Conn.

Delegate to the American Association for the Advancement of Science: M. J. Rosenau.

The next regular meeting of the society will be held in Urbana, Illinois. The chairman of the local committee is Professor H. A. Harding. A special meeting of the society will be held in San Francisco during the summer.

The American Microscopical Society at present holds only business meetings. At the recent meeting at Philadelphia the following officers were elected:

President: Professor C. A. Kofoid, University of California, Berkeley, California.

First Vice-president: Professor L. D. Swingle, University of Utah, Salt Lake City, Utah.

Second Vice-president: Dr. N. A. Cobb, U. S. Department of Agriculture, Washington, D. C.

Executive Committee: Professor J. P. Campbell, University of Georgia; Professor L. E. Griffin, University of Pittsburgh; Professor A. L. Weiman, University of Cincinnati.

Representative on the council of the American Association: Drs. H. L. Shantz and R. H. Wolcott.

The report of the custodian showed that the Spencer-Tolles research fund closely approaches $5,000. The income of this fund is now available for aid in research in any microscopic field. Applications should be made to Dr. H. B. Ward, University of Illinois, Urbana, Ill. The membership of the society was shown to have increased steadily for the last four years and now totals 399. The income for the year was $1,380. The secretary of the society is Professor T. W. Galloway, Millikin University, Decatur, Ill.

The American Folk-Lore Society met in Philadelphia, on December 30, 1914, in affiliation with the American Anthropological Association and Section H of the American Association for the Advancement of Science. Dr. Pliny Earl Goddard, president of the society, was in the chair. The papers read were as follows:

"The Relation of Folk Lore to Anthropology (presidential address)," by Pliny Earl Goddard.

"The Knowledge of Primitive Man," by A. C. Goldenweiser.

"European Tales Among the North American Indians," by Stith Thompson.

"The Magic Boat," by Phillips Barry.

Officers elected for 1915 are as follows:

President: Dr. Pliny Earl Goddard, American Museum of Natural History, New York.

First Vice-president: Professor G. L. Kittredge, Harvard University.

Second Vice-president: Professor J. Walter Fewkes, Smithsonian Institution.

Editors: Professor Franz Boas, Columbia University; Professor Aurelio M. Espinosa, Stanford University.

Secretary: Dr. Charles Peabody, Cambridge, Mass.

Treasurer: Mr. E. W. Remick, Boston, Mass.

NEARLY all the papers and practically all the discussion at the recent Chicago meeting of the American Philosophical Association centered on practical ethical questions forced to the front by present international, political, social and economic conditions. The American Philosophical Association and the Western joined in their meetings, and these two in turn had a joint session with the Political Science Association, the Association of American Law Schools, and the American Historical Association, on the subject of Democracy and Responsibility. The officers elected by the American Philosophical Association for the ensuing year are: *President,* Professor A. C. Armstrong, of Wesleyan University; *Vice-president,* Professor W. E. Hocking, of Harvard; *Secretary-Treasurer,* Professor E. G. Spaulding, of Princeton.

THERE has recently been received a notice from Professor Fehr, of Geneva, secretary of the International Commission on the Teaching of Mathematics, giving the decision of the central committee to abandon the meeting planned for August, 1915, and also to postpone the preparation of such committee reports as relate to the work of European countries.

THE new radium laboratories of Manchester Infirmary, which contain radium of the value of £20,000, raised by public subscription a few months ago, have been formally opened by the mayor of the city. A staff of experts will specialize on efforts to apply the radium for the arrest and elimination of cancer. The equipment of the laboratories is second to none in the kingdom, and in the 16 rooms allotted to this special work there is ample provision for administering the treatment to patients.

THE board of managers of the New York Zoological Society held their annual meeting on January 19. It was reported that the Aquarium drew 2,029,707 visitors last year and the park zoological gardens 2,020,433, a substantial increase over 1913. The annual maintenance cost to the city last year was 5.8 cents a visitor, the appropriations being the same as planned for next year, $247,000. On January 1 there were at the park 4,353 animals, representing 1,179 species, and the aquarium 5,169 specimens of 199 species. Animals acquired during the year cost $25,000. The most notable was a female gorilla brought from Africa by an expedition directed by Mr. R. L. Garner.

THE department of public health of the American Museum of Natural History is at present engaged in the preparation of a special exhibit of military hygiene and sanitation, dealing with the health of armies, the hygiene of the individual soldier and the general problems of camp sanitation. A number of new exhibits illustrative of insect-borne diseases were added to the department's display during 1914, the most important single exhibit being a model of the flea (carrier of bubonic plague) 1,728,000 times natural size, prepared by Mr. Ignaz Matausch. The history of the bubonic plague in the past is shown by reproductions of a number of early paintings and by a series of maps illustrating the geographic spread of disease during its historic epidemics. A series of photographs of four American army surgeons who discovered the mosquito transmission of yellow fever, has been hung near the entrance of the hall.

UNIVERSITY AND EDUCATIONAL NEWS

THE alumni of Stevens Institute of Technology were told at their annual dinner in the Hotel Astor on January 23 that their ten-day campaign to raise $1,360,000 had yielded $1,164,269, and that an extension of time had been granted in which the remainder might be collected. Dr. Alexander C. Humphreys, president of the institute, made the confident prediction that the whole amount would be raised by the end of this week.

The Harvard University corporation has set aside $100,000 to pay Belgian professors who have been driven from their land by the war and may give courses at Harvard University next year.

James R. Magee, '59, has left $20,000 and a certain further residuary portion of his estate to Haverford College, to be added to the general endowment fund.

The Evans Museum and Dental Institute Building, which will be occupied by the School of Dentistry of the University of Pennsylvania, will be formally dedicated on February 22.

The Harvard Medical School will hereafter admit as regular students men who have completed two years' work in a college or scientific school of high rank, provided they present certificates (*a*) that they have stood in the upper third of their class, (*b*) that one year's course has been taken in physics, biology, general chemistry and organic chemistry, and (*c*) that they have a reading knowledge of German or French.

DISCUSSION AND CORRESPONDENCE

PROFESSOR DALY'S IGNEOUS ROCKS AND THEIR ORIGIN

To the Editor of Science: Permit me to say a few words in regard to the criticism[1] by Mr. J. P. Iddings of a book recently published by Mr. R. A. Daly and entitled "Igneous Rocks and Their Origin." The criticism is of the destructive, not to say the volcanic, type, and one may well imagine Mr. Iddings laying down his pen with the deeply felt conviction that a heretical and dangerous book has finally been disposed of.

I am afraid Mr. Iddings underestimates the strength of his opponent and he probably does not realize what strong influence the Daly theories, particularly the stoping theory, have on the younger generation of geologists. Mr. Iddings thinks that the author of this book suffers from an exuberant, if not a disordered, imagination. What Mr. Daly thinks about the imaginative qualities of his critic has not, so far, been made public. An impartial observer would probably say that the ideal petrologist would be produced could a "syntectic" assimilation be effected of the two.

[1] Science, November 13, 1914.

It seems to me that Daly's book is one of the best ever written on the subject of igneous phenomena. The principal facts are assembled in the first part of the book, illustrated in abundance from the best sources and from occurrences all over the world. In the second part the theories and hypotheses are set forth, and illustrated in the same lavish manner from the whole world's literature. It is not necessary to agree with all of the author's views; I certainly disagree most heartily with some of them. The book is not a "college petrography" to be put into the hands of the beginner, but the advanced student can not fail to be stimulated by these suggestive and brilliant discussions. Just to point out one line of argument: The theory of gas action, cupolas and "blow-piping" is a most interesting and important subject, very largely neglected in most discourses on intrusions.

As far as his criticism of the "quantitative classification" is concerned, Mr. Daly does not stand quite alone. There are many of us who fail to see in this elaborate system anything but an admirable card classification of analyses.

I venture to suggest, in conclusion, that the unfavorable criticism in Science does not represent the impartial opinion of petrologists in general.

Waldemar Lindgren

Boston, Mass.

SCIENTIFIC BOOKS

Photo-chemistry. By S. E. Sheppard, School of Agriculture, University of Cambridge. Longmans, Green and Company. 1914. Pp. ix + 461.

In this new volume of the series of "Textbooks of Physical Chemistry," edited by Sir William Ramsay, Dr. Sheppard, of Cambridge, presents us with a most painstaking piece of work, and one which for its size is unusually comprehensive. The author presents his sub-

ject-matter in eleven chapters, of which the titles are as follows: Historical—The Measurement of Light Quantities—The Energetics of Radiation—Economic and Energetic Relations of Actual Light Sources—The Absorption of Light—Statics and Kinetics of Photo-chemical Change—Dynamics of Photo-chemical Change—Special Photo-chemistry—Radiant Matter and Photo-chemical Change—The Genesis of Light in Chemical Change—Organic Photo-synthesis.

The first four chapters do not carry us much beyond photo-physics, but give a very satisfactory résumé of those divisions of optical physics which are of primary importance in photo-chemistry. Beginning with Chapter V., the subject-matter becomes increasingly chemical in character, and the book ends with an excellent account of the more recent investigations into the character of the chlorophyll reactions.

To the reviewer the author's method of treatment seems most commendable. Such principles as may be considered thoroughly established are treated with scientific conciseness and brevity, not in general, however, without the presentation of sufficient numerical data for illustration. In dealing with matters which are still in the formative stage, a condition true of so much of photo-chemistry, the author does not dogmatize, but usually leaves the reader with quite the impression that the state of knowledge concerning the subject warrants. This makes the book valuable not only for the knowledge which it imparts, but also for its stimulus to critical thinking.

The book is made up quite directly from the original literature of the subject and is amply provided with citations and references. The author's personality shows itself not only in the thoroughness with which the material has been digested and assimilated, and later organized for the purpose of clear presentation, but also in not infrequent elucidating discussions and in occasional flashes of imaginative explanation. The reviewer's impression is that we have here the work of one thoroughly imbued with his subject, and at the same time entirely competent to handle it. The book should prove valuable not only to those desiring admittance to the charming mysteries of photo-chemistry, but should also be welcome as an additional weapon in the armory of the initiated.

S. W. YOUNG

STANFORD UNIVERSITY

The Hydrogenation of Oils; Catalyzers and Catalysis and the Generation of Hydrogen. By CARLTON ELLIS. New York, D. Van Nostrand Co., 1914. Price $4.00 net.

The book considers very fully the methods of hydrogenation, the various catalyzers, both the base and rare metals, and the mechanism of hydrogen addition. Besides this, the subjects of the analytical constants of the oils and their uses both for culinary purposes and soap making are thoroughly dealt with. About one third of the book is devoted to the methods for the generation of hydrogen, which is of prime importance: these include water gas, decomposition of hydrocarbons, steam on heated metals, acids on metals, the electrolysis of water, and the safety devices for handling the gas.

A feature of the book is the very complete citation of references and patents from the three principal languages.

The volume satisfactorily fills a decided want and may be unreservedly recommended to all interested.

A. H. GILL

A Text-book of Medical Entomology. By WALTER SCOTT PATTON, M.B. (Edin.), I.M.S., King Institute of Preventive Medicine, Madras, and FRANCIS WILLIAM CRAGG, M.D. (Edin.), I.M.S., Central Research Institute, Kasauli, Punjab. Christian Literature Society for India, London, Madras and Calcutta. 1913. Pp. xxxiv + 768. 84 pls. £1-1-0.

The protozoologist, parasitologist or physician who has occasion to deal with the arthropodan carriers of diseases produced by bacteria, Protozoa, or nematodes, has long been hampered in his investigation by reason of

the relative inaccessibility of the pertinent entomological literature. It is widely scattered in expensive journals of restricted circulation, often out of print, and very generally not to be had under any circumstances by workers on the firing line of research in the tropics far from libraries. To investigate even the commonest insects such as the house fly, the flea, the louse and the bed bug, requires an extensive and expensive library and when this is in hand the entomological novice is all too often nonplussed by the exasperating hiatuses in the information available and still more by the perplexing confusion in technical anatomical nomenclature as for example in the case of the wing veins of insects, and the parts of the thorax of the house fly. Text-books of entomology contain so little of the data essential to the workers in the fields of preventive and comparative medicine that they are practically useless as aids to the inquiring specialist.

This need (which has grown so rapidly in recent years) of an adequate text-book in this field bids fair to be very adequately met by Drs. Patton and Cragg's "Medical Entomology." The book is itself a product of this need of this frontier of science, for it has been produced by two experienced workers in the Indian Medical Service, and has been adequately illustrated and well printed in India.

The reader might perhaps infer from this that the book was a provincial one adapted to the locality of its origin. The insects with which it deals are most of them cosmopolitan, often to genera, and in many important instances, as in the fly, flea, louse and some mosquitoes, even to species. But far more important than the objective cosmopolitanism of the work is the broad and comprehensive outlook of the authors and their very sincere and painstaking effort manifest throughout the work, to make the book widely useful, soundly accurate, fairly complete, and wisely proportioned. The result is a treatise which will be indispensable to every worker in medical entomology in tropical or temperate lands.

It treats *in extenso* of insect morphology, drawing its material from those genera and species of medical importance with especial emphasis upon the Diptera. The classification is likewise carefully worked out with detailed treatment where significant, as for example in the case of those most concerned or under suspicion as carriers, such as the Psychodidæ, *Tabanus, Anopheles, Stegomyia,* Œstrid larvæ, *Musca* and *Glossina.* The life-history, breeding habits, seasonal prevalence, relation to environmental factors and the methods of collecting, rearing and feeding are carefully noted and the pitfalls which await the inexperienced worker are very frequently pointed out. One chapter is devoted to the fleas, one to the Rhynchota or bugs, and another which will be especially welcomed, to the Anoplura or lice. In every case the treatment is not restricted to known carriers, but others which are equally wont to fall into the hands of inquiring specialists are included. The known relations to disease are cited as in the many species of *Anopheles,* and the types of parasites known to occur in the insect, their location in the body, and in the life history, and the modes of infection, in fact the full medical bionomics of host and parasite are all briefly summarized.

The Acari and Pentastomida receive a full discussion, especially the first-named group, and there is a brief and rather inadequate section (the last) devoted to *Cyclops* in relation to the guineaworm. A closing chapter deals with those special forms of technique in the preparation of Arthropodan tissues and organs for microscopical examination which are supplementary to the usual lines of instruction given in medical education.

Brief bibliographies of the most important papers, synoptic keys of large groups such as *Anopheles,* by locality, for example of the Philippine Islands, simple but clear and adequate and fairly abundant illustrations, a full index, and a well organized and clearly written text all combine to render very useful an excellent scientific treatise. The defects due to inadequate editing in matters of correlation of references and in elimination of some obscurities of statement, to incomplete or inconveniently located explanations of figures,

and to some important omissions in bibliographies may well be corrected in a later edition.

CHARLES ATWOOD KOFOID
UNIVERSITY OF CALIFORNIA

SPECIAL ARTICLES

THE SIMPLEST CONSTITUENTS REQUIRED FOR GROWTH AND THE COMPLETION OF THE LIFE CYCLE IN AN INSECT (DROSOPHILA)

THE green plants are able to build up all the complicated proteins, polysaccharides and fats of their tissues from nitrates, phosphates and sulphates, on the one hand, and from CO_2, on the other. Those microorganisms which can not form sugar or starch from CO_2 must be offered a more complicated compound than CO_2 for the synthesis of their carbohydrates. They may be able, however, to form all their proteins from an ammonium salt or a single amino-acid. This astonishing synthetic power is in sharp contrast to the behavior of mammals which, according to Osborne and Mendel, can not grow unless one or more proteins are offered to them, for the reason that they lack the power of manufacturing the majority of amino-acids required for the building up of the proteins of their body.

Recent experimenters have pointed out that in addition to the chemically well-defined constituents of food, other more or less mysterious constituents, which only the living body can produce, are required for the growth of mammals. Thus Hopkins, and Osborne and Mendel have found that certain unknown constituents of milk or butter have a specific effect upon the growth of rats, and Allen has found that even a Diatom (*Thalassiosira*) grows incomparably better if one to four per cent. natural sea water is added to the culture medium.

It seemed of interest to find out which substances are required for the growth and the completion of the life cycle of such highly specialized animals as insects. The banana fly (*Drosophila*), on account of the ease with which it can be raised, served as an object for our investigations.

We wish to report only on one group of the experiments we have made, namely, those referring to the source of nitrogenous compounds required for the growth and the complete life cycle of these insects. Our culture medium consisted of a solution of the purest cane sugar or grape sugar obtainable, or of both, to which certain inorganic salts (Kahlbaum's purest) were added. To this medium was added a very small quantity (about 0.25 gram) of mechanically macerated Schleicher and Schüll filter paper (No. 589, "Blue Ribbon"), chiefly to keep the flies from drowning and to facilitate the raising of the larvæ. Dr. Levene was kind enough to have a nitrogen determination of the filter paper made, which showed that its nitrogen content is 0.008 per cent. In such a solution the flies laid their eggs. The larvæ hatched and increased slightly in size during the first days, but then their growth stopped, although they lived for a considerable time. If, however, a small quantity of one or two amino-acids, *e. g.*, alanine or glutaminic acid or others, or certain ammonium salts, *e. g.*, ammonium tartrate or succinate or a combination of one ammonium salt and one amino-acid, was added, the larvæ grew to full size and metamorphosed into pupæ and normal flies.

In these experiments everything used was sterilized, and in addition the culture media were heated for fifty minutes to about 100° C.; but since the flies were not sterile, the development of bacteria was not excluded. The flies were removed as soon as a sufficient number of eggs had been laid. In the majority of experiments no visible fungus formation occurred. When visible fungus growth took place the larvæ, as a rule, soon died or failed to develop.

If in these experiments the larvæ were actually able to manufacture all the complicated nitrogenous compounds of their body from one or two amino-acids or from one ammonium salt, without the aid of bacteria, it would indicate a power of synthesis equal to that of bacteria. In this connection it is of importance that the larvæ of the banana fly can be raised on their natural vegetable food without bacteria. Thus Guyénot has succeeded in raising aseptically forty successive generations of *Drosophila*, thereby proving that for

the normal nutrition of *Drosophila* no bacterial action is required.

It will be our next task to attempt to raise the flies aseptically on our artificial culture media, to decide whether or not in our experiments bacteria performed the work of synthesis for the larvæ.

It was natural to raise the question to what extent the nitrogen content of the filter paper contributed to the result. The fact that no larva was able to grow on filter paper, water, sugar and salts alone indicates that the nitrogen content of the filter paper played practically no rôle in the nutrition. Moreover, the amount of N contained in the filter paper was negligible compared with the amount of N added in the form of amino-acid or ammonium salts. One culture contained, as a rule, 200 mg. glycocoll or other amino acid, *i. e.*, roughly between 30 and 40 mg. of nitrogen. The 250 mg. of filter paper added to the culture contained only 0.02 mg. of nitrogen. The nitrogen in the filter paper was therefore about between 1/2,000 and 1/1,500 of the total nitrogen in the culture medium. Nevertheless, it is a fact that in liquid cultures without filter paper—in this case glass beads were used to prevent the drowning of the flies—the yield of larvæ was very much smaller than with filter paper. It should also be stated that the larvæ ate little if any of the filter paper. It will be one of the tasks of our further experiments to find out what caused the difference in the two cases.

JACQUES LOEB

THE ROCKEFELLER INSTITUTE
FOR MEDICAL RESEARCH,
NEW YORK

THE BOTANICAL SOCIETY OF AMERICA

THE ninth annual meeting of the Botanical Society of America was held in the Medical School of the University of Pennsylvania, Philadelphia, Pa., December 29–31, 1914. The following officers were elected for the ensuing year:

President—John M. Coulter.

Vice-president—R. A. Harper.

Treasurer—Arthur Hollick.

Councilor—W. F. Ganong.

The resignation of George T. Moore as secretary was accepted and Mr. H. H. Bartlett, of the Department of Agriculture, elected to fill the unexpired term.

The council for 1915 will consist of above officers and George P. Atkinson and David Fairchild.

The following botanists were elected to membership: Adeline Ames, Department of Agriculture, Washington, D. C.; E. G. Arzberger, Bureau of Plant Industry, Washington, D. C.; Freda M. Bachmann, Milwaukee Downer College, Milwaukee, Wis.; Samuel M. Bain, University of Tennessee, Knoxville, Tenn.; A. L. Bakke, Ames, Iowa; Henry W. Barre, Clemson College, S. C.; H. P. Barss, Oregon Agric. Coll., Corvallis, Oregon; R. Kent Beattie, Bureau of Plant Industry, Washington, D. C.; Albert T. Bell, University of Louisiana, Baton Rouge, La.; H. M. Benedict, University of Cincinnati, Cincinnati, O.; R. C. Benedict, 2303 New Kirk Ave., Brooklyn, New York; Charles Brooks, Bureau of Plant Industry, Washington, D. C.; E. P. Bicknell, 30 Pine St., New York City; Guy R. Bisbey, Brooklyn Botanic Garden, Brooklyn, N. Y.; Harry P. Brown, 219 Linden Ave., Ithaca, N. Y.; Stewardson Brown, 20 East Penn St., Philadelphia, Penna.; Edward Sandford Burgess, Hunter College, New York City; Gertrude S. Burlingham, 556 Lafayette Ave., Brooklyn, N. Y.; George H. Chapman, Mass. Agric. College, Amherst, Mass.; C. Harvey Crabill, Va. Agr. Exp. Sta., Blacksburg, Va.; Richard O. Cromwell, North Carolina Agric. Exp. Sta., West Raleigh, N. C.; Gilbert Cameron Cunningham, Burlington, Vt.; Charles C. Deam, Bluffton, Indiana; W. W. Eggleston, Dept. of Agriculture, Washington, D. C.; John H. Ehlers, Univ. of Michigan, Ann Arbor, Mich.; Julia T. Emerson, 131 East 66th St., New York City; T. J. Fitzpatrick, Cotner University, Bethany, Nebraska; Eloise Gerry (U. S. Forest Service), 616 Lake St., Madison, Wis.; Melvin R. Gilmore, Neb. His. Soc. Museum, Lincoln, Nebraska; John P. Helyar, New Brunswick, New Jersey; Bascombe Britt Higgins, Georgia Exp. Sta., Experiment, Georgia; H. B. Humphrey, Dept. of Agric., Washington, D. C.; L. M. Hutchins, Bureau Plant Industry, Washington, D. C.; H. S. Jackson, Oregon Agric. College, Corvallis, Oregon; Cyrus A. King, Erasmus Hall High School, Brooklyn, N. Y.; B. F. Lutman, University of Vt., Burlington, Vt.; Fred McAllister, University of Texas, Austin, Texas; Walter B. McDougall, University of Illinois, Urbana, Ills.; S. M. McMurran, Bureau of Plant Industry, Washington, D. C.; K. K. Mackenzie, 139 North Walnut St., East Orange, New Jersey; W. E. Manewal, Univ. of Virginia, Charlottesville, Va.; H. F. Meier, Syracuse University, Syracuse, N.

Y.; H. G. MacMillan, Univ. of Wisconsin, Madison, Wis.; J. N. Martin, 507 Welch Av., Ames, Iowa; Edgar Nelson, Gainesville, Fla.; J. B. S. Norton, Maryland Agric. Exp. Station, College Park, Md.; P. J. O'Gara, Medford, Oregon; A. Vincent Osmun, Mass. Agric. College, Amherst, Mass.; Frederick S. Page, University of Vermont, Burlington, Vt.; A. K. Peitersen, University of Vermont, Burlington, Vt.; Fermen L. Pickett, Bloomington, Indiana; J. M. Reade, University of Georgia, Athens, Georgia; J. W. Roberts, Dept. of Agric., Washington, D. C.; Winifred J. Robinson, Vassar College, Poughkeepsie, N. Y.; John Henry Schaffner, Ohio State University, Columbus, Ohio; Annie Morrill Smith (Mrs.), 78 Orange St., Brooklyn, New York; Neil Everett Stevens, Bureau of Plant Industry, Washington, D. C.; Wilmer G. Stover, Ohio State University, Columbus, O.; G. P. Van Eseltine, U. S. National Herbarium, Washington, D. C.; Arno Viehoever, Department of Agriculture, Washington, D. C.; J. R. Weir, Bureau of Plant Industry, Washington, D. C.; John Minton Westgate, Department of Agriculture, Washington, D. C.; R. B. Whitney, Institute of Industrial Research, Washington, D. C.; Yungyen Young, University of Illinois, Urbana, Ill.; John A. Stevenson, Estacion Insular, Rio Piedras, Porto Rico.

The following members were elected Fellows: Frank M. Andrews, LeRoy Abrams, Carleton R. Ball, Joseph S. Caldwell, G. N. Collins, Arthur J. Eames, Theodore C. Frye, Leonard L. Harter, Charles F. Hottes, Lewis Knudson, Wanda M. Pfeiffer, S. B. Parish, Frederick J. Pritchard, J. B. Rorer, Charles A. Shull, Edmund W. Sinnott, Laetitia M. Snow, William C. Stevens, U. E. Safford, Walter P. Thompson, Reinhardt Thiessen, James M. Van Hook.

On the afternoon of December 30 a symposium on "The Genetic Relationship of Organisms" was held. The subject was considered under the following heads:

1. "Morphology as a Factor in Determining Genetic Relationships." Dr. J. M. Greenman, Missouri Botanical Garden.

Discussion led by Dr. A. S. Hitchcock, Department of Agriculture.

2. "The Genetic Relationship of Parasites." Dr. F. D. Kern, Pennsylvania State College.

Discussion led by Dr. C. L. Shear, U. S. Department of Agriculture.

3. "The Experimental Study of Genetic Relationship." Dr. H. H. Bartlett, U. S. Department of Agriculture.

Discussion led by Dr. B. M. Davis, University of Pennsylvania.

The address of retiring President D. H. Campbell, on "Present Tendencies in Botanical Work in America," was delivered at the dinner for all botanists on the evening of December 30.

An Endophytic Endodermal Fungus in Solanum tuberosum: E. MEAD WILCOX, GEO. K. K. LINK AND FLORENCE A. MCCORMICK.

A preliminary account of an endophytic fungus in *Solanum tuberosum.* This fungus is found throughout the whole plant but is confined to the endodermis, and, in the usual vegetative propagation of the potato proceeds from the tuber through the shoots to the daughter tubers. A discussion of its possible relation to tuberization is included.

Report on Cultures with Foliaceous Species of Peridermium on Pine Made in 1914: GEORGE G. HEDGCOCK AND WM. H. LONG.

This paper gives a summary of an extensive series of experiments with six of the foliicolous species of *Peridermium* on pines of the United States, viz., *Peridermium acicolum* Underw. & Earle, *P. carneum* (Bosc.) Seym. & Earle, *P. delicatulum* Arth. & Kern, *P. inconspicuum* Long, *P. intermedium* Arth. & Kern, and *P. montanum* Arth. & Kern. A total of 712 inoculations were made with these species and the species of *Coleosporium,* of which these *Peridermia* are alternate forms. The results of the experiments are revolutionary, since they indicate that at least four of these species of *Peridermium* and the related species of *Coleosporium* belong to one polymorphic species, and that the transfer from one herbaceous host to another is accomplished through the aecial forms in the pines.

Origin and Development of the Lamellae in Coprinus comatus, atramentarius and micaceus: GEORGE F. ATKINSON.

The origin and development of the lamellae is described and compared with the two types already known in Agaricus and Amanitopsis.

The Specific Identity of Phallus impudicus and Dictyophora duplicata: GEO. F. ATKINSON.

The only differential character between these two species is the possession of an indusium by the latter. The indusium varies in strength of development. Sometimes it is strongly developed, sometimes very weakly so, sometimes wanting or only a fundament of it in the embryonic stage.

The Relationship of Endothia parasitica and Related Species to the Tannin Content of the Host Plants: MEL. T. COOK AND GUY WEST WILSON.

Endothia parasitica (American and Chinese strains), *E. radicalis* and *E. radicalis mississippiensis* were grown on a culture medium to which had been added different percentages of commercial tannin and special extracts prepared by Mr. George A. Kerr. Extract "1-X" was soluble in water; "2-X" in water and alcohol; both were tannins, and the second between 95 and 100 per cent. pure. A third extract, "3-X," contained the coloring matter which is usually estimated as tannin. The results of the experiments indicate (1) that commercial tannins are variable and probably not pure tannin; (2) that ordinary commercial tannin and pure tannin extracts are not the same; (3) that we do not know the form or quantity of tannin or tannin-like substances with which the fungus comes in contact in the host plant; (4) that the food supply influences the vigor of the fungus and its power of resistance; (5) that high percentages of tannin usually cause a retardation of germination, frequently followed by an abnormal growth of aerial mycelium; (6) *E. radicalis mississippiensis* was most resistant, *E. parasitica* second and *E. radicalis* third; (7) that the American strain of *E. parasitica* was more resistant than the Chinese strain; (8) *E. parasitica* may feed to some extent on the tannin; (9) specially prepared pure tannin extracts were less toxic than commercial tannin; (10) coloring materials which are usually estimated as tannins were toxic; (11) tannic acid is toxic to many parasitic fungi, but there are other compounds associated with it which are more toxic and which may be more important in the economy of the host plant.

A New North American Endophyllum: J. C. ARTHUR AND F. D. FROMME.

The supposed aeciospores of *Aecidium tuberculatum* Ellis & Kellerm. were found to produce promycelia and basidiospores when germinated on the surface of water or of a non-nutrient agar or gelatine. They are, therefore, to be considered teliospores of the same character as those present in the genera *Endophyllum* and *Gymnoconia.* The morphological features of this species, especially the cupulate, bullate sorus and the presence of a peridium, together with the habit of perennating in the host are characteristic of the genus *Endophyllum.*

The fungus occurs on species of *Callirhoe, Sidalcea* and *Althaea* in Kansas, Nebraska, Colorado and Wyoming.

This is the first North American rust whose assignment to the genus *Endophyllum* has been proved by germination tests.

How to Use Aecium and Similar Terms: J. C. ARTHUR.

The terms pycnium, aecium, uredinium and telium and their derivatives were introduced into the terminology of mycology by the writer in 1905. These terms were intended to meet certain definite requirements, and not as simplified forms of terms in common use. They have been accepted by many writers, either wholly or in part, and have been accorded a place in recent large dictionaries. The present paper is intended to point out the application of the terms, and to show wherein some extension of the terms has developed which impairs their value and is likely to lead to confusion of ideas.

Cultures of Uredineae in 1912, 1913 and 1914: J. C. ARTHUR.

The present report continues a series extending over sixteen consecutive years on the results obtained from protected cultures of various species of rusts. Out of the very large number of trials made during the three years covered by the report, about seventy were successful in producing infection, involving about thirty species. Probably half the successful cultures do little more than confirm previous work with the same species. A large part of the remainder, however, extend our knowledge of the species considerably. Some show that what have been considered valid species, *e. g.*, *Puccinia tosta, P. vulpinoidea* and *P. Dulichii,* are to be reduced to synonymy. A few cultures demonstrated the full life history of species never before cultured.

The North American Species of Allodus: C. R. ORTON.

The genus *Allodus* of the Uredinales was founded by Arthur in 1906 and embraces those species of the genus *Puccinia* auct. which have only pycnia, aecia (aecidium type) and telia in their life cycle. The present study has been made almost entirely from the taxonomic standpoint and shows in North America about forty-eight species.

Diagnostic descriptions and a key to the species are included, together with discussions and notes of interest to investigators in this class of fungi.

Foreign species have been carefully compared, but are not included in the present paper.

Correlated species of rusts in the genera *Dicaeoma, Dasyspora* and *Uromycopsis* have been enumerated so far as time has permitted, and show some interesting genetic relationships.

North American Rusts with Caeoma-like Sori: C. A. LUDWIG.

This paper takes up a discussion of the caeoma-like stage in the life history of certain North American rusts. A caeoma is understood to be a structure in which the spores are catenulate and the sorus is not delimited by peridium, paraphyses, or similar means for preventing true coalescence of sori. The material thus included is divided into five groups represented by the genera *Coleosporium, Melampsora, Neoravenelia, Gymnoconia* and *Eriosporangium* (in part). An attempt is made to arrange the species of *Coleosporium* chiefly according to their morphological characters with a view to the ultimate combination of some of them, since it seems likely that there are "more species of *Coleosporium* in the books than in nature." In the *Melampsora* group one new combination is made and one new species described. In the genus *Eriosporangium* the species *E. Hyptidis* (M. A. Curt.) Arth. is shown to have a distribution limited to the United States instead of extending to the West Indies and Central America, as heretofore considered.

The Penicillium Group—Verticillatae of Wehmer: CHARLES THOM.

A series of strains of *Penicillium* beginning with the ascugerous form of *P. luteum* and ending with *P. purpurogenum* are linked into a series by certain common characters. The conidiophore produces a single whorl of fertile branches (metulae). Wehmer uses this character to name a section, Verticillatae, of the genus. Each branch bears a verticil of sterigmata or conidia-bearing cells, closely parallel, enlarging from the base upward 5–8 microns, then tapering to form a lanceolate point ending in a conidium-producing tube, with a total length from 12 to 15 microns. The conidia in the series are elliptical, or more or less fusiform, rarely approach to globose, smooth or slightly rough, with a majority of spores in each culture, showing a size typical of the strain, while some vary widely enough to approach the range of size found in the group 2 to 3 by 2.5–4 microns. In colony character, the surface mycelium shows yellow granules which in some become reddish with age and changed reactions. The amount of yellow depends (1) upon the amount of surface growth, hence becomes abundant if the colony is floccose or is very slight in strains with short, separate conidiophores; (2) in the quantity of green conidia produced thus *P. luteum* shows only a trace of green and *P. purpurogenum* only a trace of yellow.

The species at the *P. luteum* end of the series produce orange shades in substrata containing sugars with only partial, or slow, transformation to red. *P. purpurogenum* and its close allies produce only traces of this orange color, but an abundance of a rich red coloring matter. Cultures will be shown to illustrate these points.

Spermatia of the Higher Ascomycetes: B. B. HIGGINS.

While studying the life cycle of some fungous parasites during the last two years, spermatia have been found in some twenty species. In all cases studied they develop late in the fall simultaneous with the development of young stages of the ascocarp and, in at least eleven species, with carpogonial structures.

These twenty species are scattered through four orders of the Ascomycetes, viz., *Phacidiales, Perisporiales, Dothidiales* and *Sphaeriales,* which indicates that spermatia are of quite general occurrence and may have an important bearing on the classification and relationships of the group.

The Papulospora Question as Related to Ascobolus: B. O. DODGE.

Species of fungi producing so-called *Urocystis*-like spores, papulospores, are found in several widely separated groups. Many of such forms have been connected with hypocreaceous Ascomycetes.

I have found a *Papulospora* closely associated with *Ascobolus magnificus* either as a parasite or as an asexual spore form of the *Ascobolus.* If the former is the case the mycelium of the parasite is intrahyphal; if the latter be true, then the phenomenon known as "Durchwachsung" is extremely complicated in the mycelium of this *Ascobolus.*

Further recent comparisons of papulospores with those of *Urocystis* and their description as independent Hyphomycetes are quite beside the question. It is plain that they are spore bodies either of the perfect stage of the fungus with which they are associated or of a parasite upon that fungus.

The Effect of Centrifugal Force on Plants: F. M. ANDREWS.

Climatic Distribution of the Various Types of Angiosperm Leaf-Margin and Their Physiological Significance: I. W. BAILEY AND E. W. SINNOTT.

Root Habits of Desert Plants and the Reaction of Roots to Soil Temperature: W. A. CANNON.

There are three well-marked types of roots of

the desert perennials. These are in brief: (1) roots which never penetrate the ground deeply, whatever may be its character. Most cacti have roots of this kind; (2) roots which penetrate deeply and which have a few or no roots near the surface of the ground. A typical example is found in *Koeberlinia,* although *Prosopis,* also, usually has roots of this type. And, finally, (3) many plants have roots which are intermediate between these extreme forms, and which may be said to be of a generalized character. *Covillea,* and many other species, have generalized root-systems.

The absorbing roots of the superficial type, type 1, lie, for the most part, from 5 to 15 cm. beneath the surface, while the anchoring roots are usually not much over 30 cm. deep. Since most of the roots of this type are absorbing roots, it follows that most of the roots are placed close to the surface of the ground. The deeply placed roots, type 2, on the other hand, may lie from 2 m. to 5 m. and much deeper, and have few superficial absorbing roots. The generalized root-systems may occupy any horizon between immediately beneath the surface of the ground and a depth of 2 m. or over. There is apparently no differentiation into anchoring and absorbing roots in class 2 and class 3.

A study of the mean maxima soil temperatures for a depth of 15 cm. and 30 cm. shows that the annual swing is from 46.5° F., in January, to 94.5° F., in July, at the shallower depth, and from 39.0° F., to 87.5° F., at the greater depth. Thus there is a difference at the beginning of the most active growing season of 7° F., in soil temperatures between a depth of 15 cm. and a depth of 30 cm. The temperature decreases with depth, so that as far as the records show, at depths less than 15 cm. the maxima temperatures in midsummer are greatest.

From the striking difference in root habit and from the marked difference in soil temperatures which comes with variation in depth, it follows that, in nature, plants having root habits of so diverse a character as has been given must needs be exposed to widely different temperature conditions of the soil.

Associated with the fact last presented is the one that perennials, with different root habits, have each their characteristic reaction to soil temperatures. For example, *Prosopis,* with a deeply penetrating root-system, exhibits, so far as its roots are concerned, active growth between temperatures (less than) 15° C. and 42° C. While *Fouquieria,* with a root-system resembling very nearly that of the cacti, exhibits little root growth in soil temperature under 20° C., and the same is true of *Opuntia versicolor.* The rate of growth increases with temperature rise until an optimum is reached between 30° C. and 35° C., although growth continues to 40° C., and above.

Thus, to an extent not now known, perennials with strikingly different root types show unlike and characteristic response to soil temperatures. It is thought that the difference in temperature response, coupled with differences in soil temperature, are the definitive factors which bring about the characteristic distribution in the soil of the roots of the species studied. It is largely because of these conditions, also, that "exposures" are so important in determining the characteristic distribution of many species, especially in arid or semiarid regions.

Effect of Temperature on Glomerella: C. W. EDGERTON.

Different species or strains of the genus *Glomerella* respond differently to different temperatures. One form, the one found on bean, *Colletotrichum lindemuthianum,* is very susceptible to high temperatures, growth ceasing at about a temperature of 31° C., thus explaining why this form is not prevalent during the hot part of the summer or in warm climates. The different *Glomerella* strains fall into several classes in regard to the temperature factor. These classes are represented by such forms as *Collectotrichum lindemuthianum, Colletotrichum lagenarium,* a slow-growing form from apple, a fast-growing form from apple, and *Gloeosporium musarum.* Nearly fifty different cultures have been grown at temperatures ranging from 14° C. to 37.5° C.

The Nature of Antagonism: W. J. V. OSTERHOUT.

As the result of his studies on permeability the writer finds it possible to predict what substances will antagonize each other in their action on living tissues. This opens the way to a general theory of antagonism.

The Chemical Dynamics of Living Protoplasm: W. J. V. OSTERHOUT.

By means of electrical measurements it is possible to follow reactions in living protoplasm without interference with the progress of the reaction or injury to the protoplasm. It is thus possible to determine the order of the reaction and to ascertain whether the reaction is reversible. It appears in many cases that the reaction is reversible up to a certain point; beyond this it is irreversible. The reasons for this are discussed.

The Nature of Mechanical Stimulation: W. J. V. OSTERHOUT.

The chief difficulty which a theory of mechanical stimulation must meet is the production of chemical reactions by a mechanical disturbance. This difficulty is met by supposing that the mechanical disturbance breaks down semipermeable surfaces, thus allowing substances to react which were previously kept apart. Experimental evidence is brought forward in support of this view.

Studies in Plant Oxidases: G. B. REED.

1. *Evidence for the General Distribution of the Oxidases.*—Some algae which have been reported to be without oxidases were found to contain a ferment capable of activating the oxidation of a specific group of compounds.

2. *The Formation of Indophenol Granules.*—Indophenol granules were found to form in cells which had been killed by agents which do not affect oxidases, but did not form in cells killed by agents known to destroy oxidases.

3. *On the Separation of Oxidase Reactions from the Caralase Reaction.*—By subjecting colloidal platinum to active oxygen at an anode its oxidase activity towards gum guaiacum and potassium iodide was increased, while its catalase activity was decreased; and by treating with active hydrogen at a cathode the opposite effects were produced. Bright platinum after anodic oxidation has a definite oxidase action, but no catalase action. Some plant extracts were found which contained oxidases, but no catalase.

4. *An Acid-stable Oxidase.*—While the oxidases are ordinarily inhibited by a slight degree of acidity, an oxidase was obtained from pineapples and some other fruits capable of withstanding 0.1 M. HCl.

Enzymes of the Marine Algæ: A. R. DAVIS.

Continuing the work begun with *Fucus*, isolation, and identification of enzymes occurring in representative marine forms of the greens, browns and reds has been carried on. The results obtained show certain differences for the different groups of algæ: carbohydrases attacking the various polysaccharides are generally distributed in the greens and reds; when present in the browns they are much less active, and in a few genera have not yet been detected with the methods used. Compared with potato leaf tissue prepared in the same way, the carbohydrase activity of *Ulva lactuca*, the most active form studied, was about half.

Proteinases acting upon albumin, legumin and peptone in neutral and alkaline solution were isolated from the majority of the forms worked with and, as was true for the carbohydrases, were most active in certain of the greens and reds. No amidase action was observable.

With the exception of a few forms lipase was found to be very generally present, being especially active in *Chondrus* and *Desmerestis;* on the other hand, fatty esters were not acted upon.

Oxidases and peroxidases were found in but one form—*Agardhiella*. In this both were quite active, comparing favorably with potato tuber tissue. Catalases were present in all forms.

The total number of enzymes isolated was small when compared with the tissues of the higher plants, and their action decidedly slower. In general this action was greater in the greens and the reds than in the browns.

Concerning the Measurement of Diastase Activity in Plant Extracts: CHAS. O. APPLEMAN.

Several methods have been proposed for the measurement of the velocity of diastase activity in plant extracts. The procedure adopted by several investigators is based upon the determination of the amount of reducing sugar, usually calculated as maltose, produced by the action of a definite amount of extract upon an excess of soluble starch for a definite length of time at constant temperature. The Kjeldahl "law of proportionality" is sometimes observed and sometimes ignored. The general inapplicability of this method for plant extracts is very strikingly shown in the following table, which refers to the diastase activity in glycerine extracts from cold storage potatoes:

TABLE I

Date of Analysis	Increase in Milligrams of Sugar at 40° C. Per Hour Per 100 Grams of Potato Pulp: Total Reducing Sugar Calculated as Maltose	Total Sugar
November 28	17.0	3.6
December 20	24.6	3.7
January 13	81.9	3.7

Calculated on the basis of increase in total reducing sugars or maltose in the extract after incubation with soluble starch, the tubers would show a very marked increase in diastase with storage, but when calculated on basis of increase in total sugar, the diastase activity remains practically constant. The amount of sucrose in the tubers increases with cold storage. It is extracted with the diastase and is inverted at the incubation temperature, according to the law of the mass action.

Since non-reducing, hydrolyzable sugars are present in many plant tissues and are subject to wide variation in the same tissue, the above described method in unmodified form is not reliable.

Electrolytic Determination of Exosmosis from the Roots of Anesthetized Plants: M. C. Merrill.

Subjecting growing plants of *Pisum sativum* to the influence of illuminating gas and ether vapor causes a marked exosmosis from the roots. The plants were grown for several days in full nutrient solution and, after thorough rinsing of the roots, were placed in redistilled water whose specific conductivity was approximately .000002. Immediately afterward the plants were subjected for varying periods to the gas or vapor, and the effect determined by frequent measurements of the conductivity of the water as contrasted with that in which control plants were placed and also by subsequently growing fresh seedlings in the water.

The exposures were made in all cases under bell jars. Where the roots were exposed directly to the anesthetics the resulting exosmosis was more rapid than where the roots were kept in the water during the exposure. In the former case the root turgor decreased greatly, while in the latter case the tops were affected, but the roots remained normal in appearance even though the exosmosis was abundant, thus indicating a disappearance of mineral nutrients from the tops. With older plants the increased conductivity was less than with younger plants, thereby indicating greater resistance to the anesthetics.

Some Relations of Plants to Distilled Water and Certain Dilute Toxic Solutions: M. C. Merrill.

A careful determination was made of the interval during which *Pisum sativum* seedlings could grow in redistilled water and in certain toxic solutions, and then recover when later placed in full nutrient solution. The benefits to be derived from renewing the distilled water every four days, as contrasted with the condition where it was not renewed, were evidenced in most cases by better growth in the distilled water or greater recovery in the full nutrient solution. Horse beans (*Vicia faba*) were more marked than *Pisum sativum* in their behavior toward the renewal of the distilled water, those in which the distilled water was renewed showing more than double the growth. Bacterial and fungous action is undoubtedly an important factor, as demonstrated by the effect of boiling the water. The evidence indicates that there are several factors entering into the so-called harmful action of distilled water. Striking changes in the conductivity of the distilled water were found when plants were placed in it during various stages and conditions of growth.

Revegetation of Abandoned Roadways in Eastern Colorado: H. L. Shantz.

A roadway consisted of a trail formed by driving repeatedly over the short grass sod. After a few years a new road was formed at the side of the old trail. In this way many roads were formed and successively abandoned. The plant succession on these abandoned roadways consists of an early and late ruderal association followed by either the *Artemisia-Gutierrezia* association or the wire-grass association. The final stage or Grama-Buffalo grass association becomes established in from twenty to thirty years.

Is the Flora of the Prairie and Steppe of Arctic Origin?: B. Shimek.

The conclusion of the paper is opposed to the widely prevalent conception that the flora of the steppes (and incidentally of the prairies) is of Arctic origin, and that the "steppe" condition is an evidence of a colder climate. The fact that certain plants (and, even more conspicuously, certain animals), more particularly in Europe, are now found only in the far north, but formerly existed much farther south, is not regarded as evidence of a much colder earlier climate in these more southerly regions, for we probably have to deal here with remnants of a formerly widespread flora and fauna now largely restricted through man's influence.

Comparisons are made of plant lists showing distribution in both Europe and North America, and on this basis, and on the basis of structural adaptation to habitat, and habit, the conclusion is drawn that the plants of these treeless areas reached their present state under the influence of dry conditions, and that their present distribution was accomplished by advance from regions south of the glacial limit.

Growth-forms of the Flora of New York and Vicinity: Norman Taylor.

The study of climate, through the study of the vegetative response to it, involved the dividing of all vegetation into 10 or 12 different categories. Raunkiaer has called these "growth-forms," which are based on the amount and kind of protection exhibited by the growing or perennating shoots during the winter or critical season. The usefulness of the method lies in its value as a basis of comparison between different floras, different elements of the same flora, and even smaller cate-

gories of vegetation. By calculating the percentages of the growth-forms in the flora of different regions, we get the record of the vegetative response to climate, with all its infinite variation. Applying the method for the flora of the vicinity of New York, where, excluding weeds, ferns and parasites, there are 1,907 wild species, the percentages of growth-forms are as follows:

Megaphanerophytes	.52 per cent.
Mesaphanerophytes	4.03 per cent.
Microphanerophytes	7.18 per cent.
Nanophanerophytes	3.51 per cent.
Chamaephytes	5.29 per cent.
Hemicryptophytes	33.29 per cent.
Geophytes	20.23 per cent.
Helophytes and Hydrophytes	11.74 per cent.
Therophytes	13 per cent.

The percentage of geophytes is larger than that for any region yet studied, leading to the conclusion that the climate near New York is of such a nature that the development of geophytes is especially favored. Studies were also made on the northern and southern elements of the flora of New York, and on the high-mountain species of the region; the percentage of growth-forms being given for each of these groups, and for different regions of the earth's surface to compare with the local flora near New York.

The Effect of Breeding and Selection upon the Percentage of Total Alkaloids in some Species and Hybrids of the Genus Datura: FRED A. MILLER AND J. W. MEADER.

Through selection and hybridization an attempt has been made to develop a strain of stramonium which would show an increased percentage of alkaloids over that of the commercial stramonium leaf used for medicinal purposes. All selected plants have been carefully inbred. The alkaloidal assays have been made upon samples of air-dried leaves from individual plants. The species so far used are *Datura stramonium* L., *D. tatula* L. and *D. ferox* L.

On the Nature of Mutations: R. RUGGLES GATES.

Hybrids of Œnothera biennis Linnaeus and O. franciscana Bartlett in the First and Second Generations: BRADLEY MOORE DAVIS.

Among the contrasting characters of the parent species is one especially well adapted to a genetical study. In *Œnothera biennis* the papillae at the base of long hairs follow the color of the green stems; in *O. franciscana* the papillae are bright red. Hybrids of reciprocal crosses all have red papillæ, the color thus appearing as a simple dominant. Cultures of the hybrids in the second generation totaled 1,806 plants from sowings of 3,554 seed-like structures; 1,679 rosettes sent up shoots during the season, and on every one of these plants the papillæ were bright red. There was thus a failure of the color character to segregate in the F_2 in cultures containing 1,679 plants, and its behavior was not what might have been expected from Mendelian experience. However, it should be noted that of the 3,554 seed-like structures sown 1,748 failed to germinate, although seed pans were kept for 8–10 weeks. Also that 127 plants either died during the season or else, remaining as rosettes, failed to send up shoots upon which observations could be made. It is thus possible that the absence of a class of green-stemmed recessives may be associated with this high degree of seed sterility, the cause of which is as yet not known, or with the failure of some plants to mature.

In previous papers mention has been made of the fact that the F_1 hybrids of the cross *franciscana* × *biennis* in many characters were similar to *Œnothera Lamarckiana*, differing from this plant only in relatively small plus or minus expressions of these characters. The second generation of this cross, as was to have been expected, presented a wide range of forms, and among these were a number of plants with combinations of characters that appear to have fulfilled in essentials the requirements of a synthetic *Lamarckiana*-like hybrid. Further generations from these selected plants will be grown to test their further range of variation.

A detailed account of the above-considered cultures will later be published.

Inheritance of Certain Seed Characters in Corn: R. A. HARPER.

The various pigmentations of the integument, aleurone layer and endosperm are metidentical characters in Detto's sense, that is, the same in the cells as they are in the tissues or the kernel, as a whole. The pattern in the case of streaked or mottled grains is a character of the tissue, as a whole. The form of the dent kernels is a character of the kernel, as a whole, due to the nature and distribution of the starch and other elements in the tissues. The wrinkled form of the kernels of sweet corn is more nearly identical with the shrinkage of the individual cells of the endosperm. By crossing, intermediates may be obtained between any two such contrasting charac-

ters, and selection tends to develop fixity of type, though the range of variation may at first be even higher than that of the parent types.

Inheritable Variations in the Yellow Daisy (Rudbeckia hirta): Albert F. Blakeslee.

Variations in the following characters have been found in the wild yellow daisy: absence of rays and their presence in rather definite numbers from 8 to 30 and to perfectly double forms; width of rays; diameter of head from 1 to 5½ inches; color of rays from pale straw color to deep orange; relative intensity of color in inner half of ray forming a lighter or darker ring; different intensities of mahogany color at base of ray on upper side; mahogany on under side of ray; constriction of ray at tip, at middle, or at base—those constricted at tip either rolled in or rolled out to give the "cactus" type seen in *Dahlias*—those constricted at base without change in color or characterized by lighter color or by presence of black pigment on constricted areas; transformation of rays into tubes giving "quilled" type; the position of rays, bending upward, horizontal, reflexed, straight or variously twisted; the shape and size of disk; the color of disk from yellowish green through several grades of purple to almost black; vegetative characters such as height, branching, size and shape of leaf, fasciations, etc.

Evidence from the distribution of the variants in nature and from their reappearance in sowings from open-pollinated heads shows that most, if not all, these variations are inherited. The basal splash of mahogany on the ray seems to be inherited as a simple Mendelian dominant. Other characters are being investigated.

Bud Variations in Coleus: A. B. Stout.

The phenomena of bud variation in *Coleus* and the behavior of pedigreed plants of vegetative propagation illustrate, in the case of red pigmentation, most clearly the behavior of a metidentical character, and show equally well that the distribution of colors in patterns is epigenetic in nature, and is, without doubt, due to physical and chemical processes quite analogous to the Liesegang precipitation phenomena by which Gebhardt reproduced in a most striking manner certain markings that occur in the wings of butterflies.

Plants propagated vegetatively through six generations developed two types of changes: (1) fluctuations and (2) mutations. Although the different patterns which arose were remarkably constant in vegetative propagation, each exhibited further changes in the epigenetic development and distribution of the red pigmentation. The phenomena associated with the appearance and subsequent behavior of the different bud variations are quite similar to the phenomena of variation, mutation and alternative inheritance in a seed progeny of hybrid origin.

The Morphology of the Œnothera Flower: George Harrison Shull.

The hypanthium of *Œnothera* and other Onagraceous genera is usually described in taxonomic works as a "calyx-tube." In one of my hybrid *Œnotheras* a complete series of transitional stages was presented, connecting the normal type of flower, sessile with a long hypanthium, with pedicellate flowers wholly lacking a hypanthium. This indicates that the hypanthium is of cauline nature.

The Morphology and Systematic Position of Podomitrium: D. H. Campbell.

The genus *Podomitrium* comprises two species, *P. phyllanthus* from the Australasian region, and *P. Malaccense,* which has hitherto been reported only from Singapore and New Caledonia. The writer collected the latter species in Borneo and the Philippines.

Podomitrium malaccense closely resembles in appearance a *Blythia,* and sterile plants are indistinguishable. The position of the reproductive organs of the former, in special ventral branches, at once distinguishes it from *Blythia.*

The anatomy of the thallus, as well as the form of the apical cell, is practically identical in *Podomitrium* and *Blythia.*

The antheridia in *Podomitrium* are borne on special ventral shoots. In structure, and in the scales covering them, they most nearly resemble *Mörkia* or *Calycularia.*

The archegonia are also borne in special shoots. The archegonial receptacle is very much like that of *Blythia.* The embryo is much like that of *Blythia* or *Symphyogyna,* but the basal appendage (haustorium) is somewhat less developed.

The fully developed sporophyli closely resembles that of *Blythia,* from which it differs in the more clearly marked foot, and in the presence of a very well developed apical elaterophore. The spores, in size and surface sculpturing, are hardly distinguishable from *Blythia radiculosa.*

On the whole, *Podomitrium* seems to be more nearly related to *Blythia* than to *Metzgeria,* with which it is usually associated. This study of *Podomitrium* confirms the view that there is no certain distinction to be drawn between the families Aneuraceæ and Blythiaceæ.

Fiber Measurement Studies; Length Variations: Where They Occur and Their Relation to the Strength and Uses of Wood: ELOISE GERRY.

I. The results of the study of *one white pine* tree indicate: (These are based on the measurements made on 6,600 fibers from 66 specimens.)

1. The length of fibers varies with their position in the tree.

A. In (1) a disk from the butt (age 250 years, distance above the ground approximately two feet) and in (2) a disk near the top (about 82 feet above the ground) *the shortest fibers were found near the pith.* An increase in length was apparent from the center outward. This was somewhat irregular (slides). No constant fiber length was attained.

B. In 26 bolts, taken at about 2½ to 3 inches from the pith, at 4-foot intervals between the butt and the top of the tree, a tendency toward an increase in average fiber length was apparent for about two thirds of the height of the tree.

2. *The relation between the fiber length and the strength values of the wood was indeterminate; no direct effect dependent on length alone could be found.* The following indications were obtained, however:

A. From butt to top the S. G. and strength decreased but the average fiber length increased.

B. In some loblolly pine the late wood was about twice as strong as the early wood; the relative fiber length was as 2.69 is to 3.03 mm.

C. In Rotholz the fibers are also stronger (in compression) and shorter than those in normal wood.

That is, the shortest but at the same time the thickest-walled fibers were present in the strongest specimens.

II. The general range of variation in fiber length was not found to be greater within the species than in the individual tree.

1. Longleaf pine (*Pinus palustris*) (1,700 measurements of 15 specimens).

2. Douglas fir (*Pseudotsuga taxifolia*) (900 measurements of 5 specimens).

The longest fibers were found in the earliest springwood; the length then decreased gradually and the shortest fibers were present in the last formed layers of the ring.

III. Certain general relationships also noted:

1. The root fibers of longleaf pine and white pine were found to have a fiber length as long as or even longer than that of the trunk fibers. This may enable the pulp mill to utilize stumps obtained where land is being cleared or the chips from which resin has been extracted for a strong craft pulp.

2. In general the hardwoods or angiosperms have a shorter fiber than the softwoods or gymnosperms. All other things being equal, the strength of a pulp varies with the length of the fibers composing it.

3. The early or springwood fibers are always longer than the late or summerwood fibers. The data obtained from about 80 specimens indicated that less than one fourth of the fibers found in every hundred macerated fibers were summerwood. In two cases the summerwood fibers made up about one third of this amount; in both cases this large number of fibers was found in wood from very low down in the tree. The per cent. and character of the summerwood fibers are significant factors in determining the character of a wood to be used for pulp.

Changes in the Fruit Type of Angiosperms Coincident with the Development of the Herbaceous Habit: E. W. SINNOTT AND I. W. BAILEY.

Angiosperms with fleshy fruits are almost invariably trees, shrubs or climbing herbs. Terrestrial herbs practically always have dry fruits. Herbs seem to have been developed from woody plants in relatively recent times. It is therefore evident that with this change in habit there must have been changes in many families from a fleshy type of fruit to a dry one. This is apparently due to the fact that most frugiverous birds are reluctant to feed on the ground and that herbs have consequently been obliged to develop new methods for seed dispersal.

Some Effects of the Brown-rot Fungus upon the Composition of the Peach: LON A. HAWKINS.

This paper describes the results of several series of experiments on the effect of the brown-rot fungus upon certain carbon compounds in the peach fruit. In the experiments one half of the peach was inoculated with the fungus, while the other was retained sterile under the same moisture and temperature conditions as a control. At the end of two or three weeks the two portions were analyzed. It was found that in the rotted portion the pentosan content was practically the same as in the sound half; the acid content was increased; the amount of alcohol-insoluble substance which reduces Fehling's solution when hydrolyzed with dilute HCl was decreased; the total sugar content was decreased, while the cane sugar practically disappeared.

Senile Changes in the Leaves of Vitis vulpina and Certain other Perennial Plants: H. M. Benedict.

It has been found by an investigation extending through a period of seven years that in the leaves of *V. vulpina* and other plants there occurs evidence of senility. Similarly aged leaves of differently aged plants (age being reckoned from date of last reproduction from seed) show marked differences in the extent of veinage. The aggregates of mesophyll cells enclosed within the smallest veinlets, which may be termed vein-islets, are uniformly smaller in leaves of old plants than in leaves of young plants. In other words, leaves of old plants have a higher percentage of vascular tissue than leaves of young plants; consequently they are less efficient photosynthesizing organs, and this has been proved by experiment. A formula is presented showing the method for determining age of *Vitis vulpina* from the character of its veinage. The juvenile veinage is restored only after sexual reproduction. Finally, a theory of sexuality is proposed, based upon loss in permeability.

Influence of Certain Salts on Nodule Production in Vetch: Mr. Kno.

Calcium salts are essential for nodule production in vetch. The substitution of borium or strontium to a limited degree permits also of nodule development. The relation of balanced solution to nodule production has also been investigated.

Physiological Studies of Bacillus Radicicola of Soy Bean: J. K. Wilson.

This investigation confirms earlier work as regards the influence of nitrates on nodule production, and indicates in addition that sulfates in relatively weak concentration inhibit the process. Chlorides and phosphates stimulate nodule production, while ammonium salts are inhibitory. The significant fact was developed that while nodule development was prevented by the presence of nitrates, phosphates and ammonium salts, yet the organism retained its vitality in the presence of these salts. Whether the effect of the salt is upon the root, such as to make it resistant, or upon the organism can not yet be stated.

Direct Absorption and Assimilation of Carbohydrates by Green Plants: Lewis Knudson.

Confirming and extending the work of Laurent, Molliard and others, it has been found that a variety of plants are able to absorb and assimilate various sugars, including lactose. Plants employed are timothy, vetch, onion, radish, pea, cabbage, clover, flax and corn. Lactose has been found to be utilized by vetch, radish and onion but not by timothy. For corn the sugars in order of "preference" by the plant are glucose, levulose, cane sugar and maltose; for vetch, cane sugar, glucose, maltose and lactose. Experiments on the influence of concentration of the sugar on growth, influence of sugars in respiration and color production have also been made. A study of the influence of sugars in enzyme production is now progressing.

A Preliminary Study of the Chlorophyll Compounds of the Peach Leaf: Howard S. Reed and H. S. Stahl.

The investigations were undertaken with especial reference to the foliage of peach trees having "yellows." The chlorophyll compounds were extracted and separated by the use of inactive solvents. The diseased leaves differ from the healthy in both the quality and quantity of chlorophyll derivatives extracted. The derivatives have been identified by their color, solubility, spectra and other properties.

Among others, the following derivatives have been found in healthy peach leaves: chlorophyll *a*, chlorophyll *b*, phytorhodin, chlorophyllin, phæophytin, phæophorbide, methyl-phæophorbide, methychlorophyllid, phytochlorin, carotin and xanthophyll.

As the disease advances there is a decrease in the quantity of both chlorophyll and chlorophyll derivatives. The diminution of the green series is greater than that of the yellow-brown series.

Respiration in Apple Leaves Infected with Gymnosporangium: Howard S. Reed and C. H. Crabill.

The respiration of apple leaves has been studied with reference to the pathological effects of infection. Foliage was studied at various stages in the development of the disease, using both Ganong's respirometer and Sach's baryta methods. The diseased leaves uniformly produce more carbon-dioxide than healthy leaves in the same intervals. Various factors influence the process.

The Absorption and Excretion of Electrolytes by Lupinus albus in Dilute Simple Solutions of Nutrient Salts: R. H. True and H. H. Bartlett.[1]

[1] Office of Plant Physiological and Fermentation Investigations, Bureau of Plant Industry, U. S. Department of Agriculture.

The behavior of seedlings of *Lupinus albus* toward distilled water and toward simple solutions of salts containing ions regarded as essential to the normal nutrition of higher green plants was studied by the water culture method, the plants being kept in darkness. The stronger concentrations employed were comparable with the soil solution under conditions found in the vicinity of Washington, D. C. The absorption of ions from the solutions and the loss of ions to the solution were measured by the Wheatstone bridge in terms of change of electrical conductivity.

The plants give up their salts to distilled water at a variable rate until death ensues from exhaustion. Solutions of KH_2PO_4 and KCl act essentially like distilled water.

In K_2SO_4 and KNO_3 a slight absorption phase is seen in the most favorable concentrations resulting in a minimal net gain in electrolytes to the plant. Otherwise the results differ little from those seen in the phosphate and chlorid solutions. Sodium chloride affects permeability and growth essentially like KNO_3 and K_2SO_4.

In the most favorable concentrations, of $Mg(NO_3)_2$ and $MgSO_4$ there is a slight but clearly developed absorption phase resulting in a net gain of electrolytes to the plant. A net loss takes place in the more dilute solutions and in the greater concentrations toxic action develops.

In $Ca(NO_3)_2$ and $CaSO_4$ solutions all concentrations studied support an active absorption of electrolytes and apparently enable the plants not only to retain the salts already present, but also to make net gains from the solutions.

The Absorption and Excretion of Electrolytes by Lupinus albus in Dilute Solutions Containing Mixtures of Nutrient Salts: R. H. TRUE AND HARLEY HARRIS BARTLETT.

Seedlings of *Lupinus albus* were grown in darkness in graded solutions of pairs of nutrient salts, the higher concentrations being comparable with the soil solution. Absorption or excretion of electrolytes by the roots was measured as changes of electrical conductivity.

The results obtained show that the gain or loss of electrolytes by the plants is in cases influenced by the antagonistic action of ions.

The Transpiration Rate on Clear Days as Modified by the Daily Change in Environmental Factors: LYMAN J. BRIGGS AND H. L. SHANTZ.

The transpiration of a number of crop plants has been measured by means of automatic balances at Akron, Colorado, during the past three years. Automatic records have also been secured of the evaporation from a freely exposed water surface, the depression of the wet bulb, the intensity of the solar radiation, the air temperature and the wind velocity. The present paper compares the results of such measurements for clear days. The transpiration curves are based on a large number of measurements, and expose the normal behavior of these plants on clear days.

Relation of Transpiration to the Composition of White Pine Seedlings: GEORGE P. BURNS.

The experiments reported at the Atlanta meeting were repeated during the summer of 1914, with the addition of two beds in which the physical conditions were changed by means of one and two covers of cheesecloth. The seedlings were grown in five beds each with a different rate of transpiration.

Seeds were sown in May and the first analysis was made of seedlings gathered August 11. This analysis showed the following amounts of protein and soluble ash:

Seedlings	Protein, Per Cent.	Soluble Ash, Per Cent.
No shade	13.88	4.13
Half shade	16.44	4.41
Full shade	36.82	6.46
One cheesecloth	11.56	4.14
Two cheesecloth	12.31	4.15

This table again shows the high percentage of ash in the full shade bed where the rate of transpiration was very low.

A New Method in Lichen Taxonomy: BRUCE FINK.

The results of investigation of the Collemaceæ will be presented. The plants will be treated as fungi and a new type of lichen diagnosis will be presented. This will treat the anatomical characters of the lichen to the exclusion of those features of the algal host which have heretofore been included in the descriptions of these lichens. The characters of the cortices and medullæ have been carefully investigated, and several features will be presented which are new to lichen taxonomy. The sex organs have for the first time been studied with a view to ascertaining their value as diagnostic characters. Camera lucida drawings of cortices, medullæ, apothecia, procarps and spermagonia will be shown, and their taxonomic value will be discussed.

The Mechanism for Discharging the Eggs of Dictyota Dichotoma: W. D. HOYT.

The young eggs of *Dictyota dichotoma* are enclosed by thin walls showing no differentiation,

but as they mature their walls thicken and become differentiated into a thick inner and a thin outer layer. At the instant of discharge the inner layer swells and becomes gelatinous, the outer layer is irregularly ruptured, and the egg is forced through the opening, thus formed, sometimes to a distance of 0.24 mm. In escaping the egg is still enclosed by the gelatinous inner layer, but is soon set free by the solution of this layer.

The observed facts indicate that the force utilized in discharging the eggs is obtained solely by the swelling of the inner layer with the contraction of the stretched outer layer of the oogonium wall.

Both at Beaufort, N. C., and at Naples, about 65–75 per cent. of all the eggs of each crop were discharged within a single hour of a single day, beginning at about the time of the first observable traces of dawn.

The swelling of the inner layer of the oogonial wall, with the resultant discharge, did not occur in eggs that were killed by heat, cold or chemicals, and was practically or entirely prevented by anything that interfered with the life conditions. It could not be initiated by any means before the usual time for discharge, but, as the usual time approached, seemed slightly accelerated by transfer from a moist dish to sea water.

The above facts seem to indicate that the swelling of the inner layer of the oogonial wall is under the direct control of the protoplasm, or that it is accomplished by means of enzymes formed by the protoplasm and affected by the same conditions that affect the living substance. Of these two possibilities, the latter seems more probable.

Cell Division and the Formation of Colonies of Volvox: R. A. Harper.

The planes of the first two divisions of the mother cell of the young colony intersect at right angles. The plane of the third division lies so as to form the well-known cross figure. The factors determining this deviation from Sach's principle of rectangular intersection are associated with the surface tension developed in a plate made by successive bipartition of cells, and lead to the further incurving of the plate and formation of the globular colony.

Prochromosomes in Synapsis: C. A. Darling.

The work on prochromosomes by Rosenberg, Overton and others has suggested the possibility that some cells might be found the study of which would considerably increase our knowledge concerning the behavior of the chromosomes in synapsis and reduction. Such cells have been found in the Norway Maple *Acer platanoides.*

In the so-called resting stage of the nucleus of the pollen mother cell in this species are 26 definite bodies corresponding in number to the 26 chromosomes found in the vegetative cells at the time of division; most of these bodies, or prochromosomes, are distributed about the periphery of the nucleus, but a few are to be found lying close to or against the nucleus. Upon staining with safranin, gentian-violet and Orange G., these 26 prochromosomes are stained blue and the nucleolus red, so that the two are readily distinguished. At this stage the linin threads take the stain only sparingly. At least some of these threads appear to be attached to the prochromosomes; in some cases the threads are connected, forming a sort of net with nodes or thickenings; these nodes do not take the gentian-violet stain and are not definite bodies like the prochromosomes.

The prochromosomes are noticeably arranged in pairs; in some cases the two are separated by at least twice their own width, while in other pairs they almost touch each other; in no case do they appear to be connected. The prochromosomes vary somewhat in size, but so far as observations go the individuals of a pair appear to be equal.

As the period of synapsis approaches, the threads become more conspicuous and take the gentian-violet stain more readily; the prochromosomes still retaining their definite individuality appear to come closer together. The beginning of synapsis is indicated by the contents of the nucleus being drawn toward the nucleolus and collecting at one side of the nuclear cavity. The whole network of threads and prochromosomes becomes more or less massed; only in rare cases do any of the threads appear to lie parallel.

In complete synapsis only a few threads are distinguishable, especially those extending out from the synaptic knot. The prochromosomes, however, are still very apparent; in most pairs the members appear to be in contact with each other, although some are still separated. As growth proceeds the threads which extend outside of the knot become thicker and contain more chromatin, as shown by their staining reaction. These threads soon become double, the evidence indicating that this is due to a longitudinal splitting of a single thread rather than to the parallel arrangement of two separate threads. Apparently each of these thick threads is formed by the gradual flowing out of the contents of the prochromo-

somes on the thin threads to which they were attached before synapsis began, the contents of the two individuals of a pair flowing in opposite directions.

As the growth period advances these threads enlarge, become less entangled, and the splitting becomes more apparent. At this stage deeper staining bodies of different sizes are found distributed on the threads; these bodies, possibly chromomeres, are always found in pairs, one on each of the two parts of the double thread. There are usually 3 or 4 pairs of these chromomeres on each of the bivalent threads, the individuals of each pair being opposite each other and equal in size. As these bivalent threads become less entangled the number of the threads is found to be 13, one half the number of prochromosomes observed before synapsis. The details from this stage on have not as yet been worked out, but observations indicate that each of these 13 threads becomes shorter and finally forms a bivalent chromosome.

In the first division of the nucleus 13 chromosomes pass to each pole; in the reconstructed daughter nucleus 13 prochromosomes appear, but these are not arranged in pairs. In the resting nuclei of the somatic tissue the prochromosomes are present and appear to be more or less in pairs.

These observations seem to show that in *Acer platanoides* prochromosomes exist in the nucleus; that they are arranged more or less in pairs in both somatic and mother cells; that in synapsis the members of each pair unite and form a thick thread on the single thread which preceded synapsis; that this single thick thread becomes split longitudinally; that upon this bivalent thread occur paired chromomeres; and finally that each bivalent thread becomes a bivalent chromosome which divides into univalent chromosomes in the first division of the pollen mother cell.

Cytology of Sphæroplea: E. M. GILBERT.

Cleavage begins with constrictions from the plasma membrane, and the cell contents are cut into masses of varying sizes. A single row of large cells or a double row of smaller cells may be found in a single filament.

All eggs at first contain more than a single nucleus, and all but one of these disappears before the egg is fully mature.

Nuclear divisions as far as observed are mitotic and no indications of amitotic divisions, described by earlier investigators, have been found. There is no fragmentation of the nucleole to form the chromosomes.

The number of pyrenoids found in eggs varies from two to seven.

The pyrenoids vary greatly in size and each is made up of a varying number of segments. The starch is usually laid down around the pyrenoid in definite layers but at times the arrangement is very irregular. Stromatic starch is very abundant in some mature eggs.

The pyrenoids disappear from portions of filament which are active in the formation of sperms.

Fertilization does not take place until the egg is fully formed and rounded; at this time the egg nucleus lies in the center of the egg.

An Anatomical Study of the Root of Ipomœa batatas: FLORENCE A. MCCORMICK.

A preliminary paper on the anatomy of *Ipomœa batatas*. During the investigation, a fungus, similar to the one found in *Solanum tuberosum* has been found in the endodermis of the root, but so far the fungus has not been seen in the stem.

The Anatomy of a Protomyces Gall: ALBAN STEWART.

The lower parts of the stems of *Ambrosia trifida* L. are often attacked by *Protomyces andinus* Lagh, causing considerable disturbance in the tissues of the host. Large swellings are caused by this parasite, one or more of which may appear on the same plant.

Sections of these galls show, among other things, an increase in the tissues of the bark, an abnormal growth of the fibrovascular bundles as compared with non-infected parts close by, a broadening of the rays and the formation of other parenchyma elements in the bundles, areas of cambiform cells in the pith.

A gall caused by an unknown insect, probably of the order Lepidoptera, also occurs on the stems of this species of *Ambrosia*. The changes induced by this insect in the tissues of the host are similar in certain respects to those caused by Protomyces.

The Anatomy of the Punctatus Gall: ALBAN STEWART.

Andricus punctatus Bass., a hymenopterous insect of the family Cynipidæ, causes large woody galls on the stems and branches of *Quercus velutina* Lam. and other closely related species of oak. This gall possesses, among others, the following anatomical characters which are of especial interest.

A recapitulation of a similar condition of ray structure to that which occurs in traumatic wood

of related species of oak. Other characters which agree closely with general conditions in traumatic tissue are as follows: A vertical shortening of the broad rays. The presence of knarls which appear only in tangential sections of the gall. A parting of the fibers to right and left in the vicinity of the larval chambers. Areas of isodiametric parenchyma cells with lignified walls, and a shortening of many of the other cells of the wood. A reduction in the number or an entire lack of vessels. Absence of distinct annual rings of growth. A suggestion of a return of the cambium to its normal activities in the outermost layers of wood. Woody inclusions in the bark.

The Anatomy of a Peridermium Gall: ALBAN STEWART.

Large woody galls occur on the branches of the jack pine, *Pinus Banksiana* Lamb., which are caused by the infection of *Peridermium* (*Aecidium*) *cerebrum* Pk. The following anatomical differences occur in the woody portions of these galls as compared with the normal wood of this species of pine. A greatly increased production of woody tissue. An increase in the number, and a broadening of the rays both vertically and tangentially, characters which also appear in traumatic wood of this species. The presence of knarls in tangential sections. A greatly increased production of resin canals in the gall, but no such increase in the normal wood close by. A shortening of many of the tracheids as well as blunt end walls and wavy side walls of the same. Cells which partake of the character of both tracheids and parenchyma cells in their pitting. Alternate as well as opposite arrangement of pits in the walls of the tracheids. Apparently an absence of bars of *Sanio* from the walls of the tracheids in many instances.

A Note on the Leaf Anatomy of Avicennia: ALBAN STEWART.

On the Forms of Castela galapageia Hook. f.: ALBAN STEWART.

Photographing Mosses: A. J. GROUT.

When beginning the study of mosses I found identifications very difficult because of the lack of suitable and adequate literature and illustrations. I did not have access to Sullivant's "Icones" or the "Bryologia Europæa."

When as an advanced student I had access to these works I formed the ambition to put similar but cheap and simplified books within the reach of any enterprising student. My desire was to make new moss students instead of new moss species, because what we need to advance bryology in America is, first of all, more observers and collectors.

The two books I have published were illustrated by drawings, many of which were taken from the standard works mentioned above. But I saw how valuable photographs were in the study of flowers, ferns, etc., and I became ambitious to equal this work in the mosses and hepatics. To this end I have devoted my spare time for the past year or two, and I have succeeded in enlisting others. Professor Holzinger has done some excellent work.

My outfit is a Bausch and Lomb camera for micro-photography with a heavy iron base and long bellows. Instead of the cap to fit over the eye-piece of the compound microscope I put in a lens-board or boards. I have a battery of three lenses, a Wollensack Anastigmatic F. 6.8 for a 4 by 5 camera and a supplementery lens to shorten tho focus. A Beck Neostigmar 3 in focus, f. 3.5, wide angle from a motion-picture camera and a Bausch and Lomb wide angle Zeiss-protar, focal length 2¾ inches.

The Wollensack and supplement give magnifications up to 5 diameters, and the automatic shutter makes it more convenient than the others, which have to be uncapped. Also it gives plenty of illumination for focusing. The Beck gives magnifications up to 7 diameters and also admits plenty of light for focusing. The Zeiss protar is so small that focusing is difficult unless bright sunlight shines on the object, but I can get 9 diameters. To get depth the lenses were stopped down to 32, 64 or even to 128 U. S., and in strong light were given from 3 min. at 32 U. S. to 6–8 min. at U. S. 64 when cloudy bright and indoors.

If the mosses were not dry the setae would sometimes twist during the longer exposures so as to produce a bad blur. I have had better results with reflected light than transmitted light. I am undecided as to whether a black background is superior to a white or not. Against the black background every speck of dust magnified tenfold produces a disagreeable effect.

I have also tried peristomes by transmitted light under a compound microscope. I squandered more than a dozen plates on the peristome of *Ceratodon*, but its dark red color and density foiled my attempts to get anything but a silhouette.

The photographs themselves will tell you far more than I can as to my results.

GEORGE T. MOORE,
Secretary

SCIENCE

FRIDAY, FEBRUARY 19, 1915

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PROBLEMS OF GEOGRAPHIC INFLUENCE[1]

FOUR points of view will be taken with reference to our theme: its importance, its difficulties, the related sciences, and fields of investigation.

We deal here with the heart of geography. The ties, infinite in number, which bind life to the earth lead surely up to man. No other phase is so insistent and so appealing as the earth's influence upon our kind. The plant and animal world joins itself to our physical habitat to enrich our environment and multiply our problems. The first members of this association came into it from the field of geology, and these men have, from meeting to meeting and from year to year, marched steadily up toward the human goal of our science. In Mr. Roorbach's recent symposium on the Trend of Modern Geography,[2] by far the larger number directed their call for research toward the field of geographic influence. Whether we speak of influence, or response, or adjustment, matters little. Terminology will grow unbidden, if we are exact in our thinking.

Here lies the weight of our theme. We all have a duty to do in view of the ill-founded and doubtful conclusions too often set forth, and in view of the vast extent of the unknown in this field. The factors of influence are not carefully isolated. What these forces really do and how they do it are not shown. Ripley holds it certain "that the immediate future of this science

[1] President's address before the Association of American Geographers, read at the eleventh annual meeting, Chicago, December 30, 1914.

[2] "The Trend of Modern Geography," *Bull. Am. Geog. Soc.*, November, 1914.

will depend upon the definiteness with which its conclusions are stated and illustrated."[3] The rich and sometimes noble and rousing periods of Ratzel leave us often in the jungle of thought. But he made a trail in the jungle, and we who follow the trail may not blame him for unexplored corners of the forest. What Ratzel thinks about definite knowledge appears in his criticism of the so-called "climatic philosophers."[4] Here too Brunhes adds his call for precision:

> How does the climate influence us . . . it is just as necessary here, as elsewhere, perhaps more necessary, to rejuvenate current assumptions by analyzing them, for they are far too slipshod and superficial.[5]

This call for definiteness presses on every student of geographic influence, be the phase climatic or other. It is not that we can draw mathematical conclusions in any science of man, but sharp eyes and good logic will at least lift us from chaos to order.

We are thus under bond to work this field for the perfection of essential geography. But we owe a further debt, or rather, there is a mutual exchange of help in which we must not fail of our part. Geography offers help and cooperation to all sciences that deal with man, anthropology, ethnology, history, sociology, economics, psychology and comparative religion, and from each of these geography will gather data for its own perfecting.

The historian, for example, needs from the geographer a more full knowledge of environmental working, and the geographer receives in turn much from the historian. The old geography knew little of the causal and historical, and some of the old history might just as well have been staged on a flat platform projected into the interplanetary ether.

If history is to strike deep roots into the earth, if it is to set forth with full discernment, the moulding, moods, motives and movements of men, the historian will need help from the geographer; and the historian, sceptical of generalizations that are too easy and scorning overstatement, will respond with open hand to every real offering of the geographer.

When geography was poorer than to-day, Parkman wrote the human story out of its environment. James Bryce has always and without stint placed geography in the running with historical movements. And if the generalizations of Bryce, like those of Ratzel, are sometimes tinged with vagueness, let us blame, not the historian of broad outlook, but the geographer whose work is yet in arrears. Other examples are not wanting. Winsor, in dedicating his Mississippi Basin to Mr. Markham, then President of the Royal Geographical Society, writes of environment,

> I would not say that there are not other compelling influences but no other control is so steady.[6]

Mr. Edward John Payne has written a "History of the New World called America." Being no historian, I do not know the craft's estimate of that work, but I am astounded at the author's deep and broad knowledge of environment in the lands whose story he tells. The surface, the climate, the possibilities of cereal production and of the domestication of certain animals appear in such wise in relation to early American civilization, to the arts and habits of the people, as to stir the geographer to admiration. Whether all of Payne's conclusions stand fire or not, he gives an example of effort aimed at preci-

[3] W. Z. Ripley, *Pol. Sci. Quar.*, 10, 640.

[4] "Anthropogeographie," I., 83–84.

[5] J. Brunhes, Inaugural lecture, *Scot. Geog. Mag.*, 29, 312.

[6] "Mississippi Basin," Justin Winsor, following title page.

sion. This is a call to every geographer. The geographic atmosphere in Professor Turner's story of our north central west is known to us, and Professor J. L. Myres, reaching at once broadly into the fields of classic lore, anthropology and geography, is, in his person and work, living testimony to the importance of our anthropogeographic task, and to the hopefulness that lies in our attempting it.

Some historical writers are influenced little if at all by the study of the earth and lower life as elements of human environment. Even volumes professing to deal with the geographic foundation of history sometimes fail of their goal, and one preface affirms that—"the general physiography of North America is familiar enough to readers."

This, I am sure, is quite too rosy a view of the geographic situation. But I cite the limitations of some histories in no mood of criticism. Let every man build the wall over against his own house. What of assured fact or proven principle we put before the historian he has neither the will nor the power to escape. Our light is in no danger of being put under a bushel. But we have good need to see that it is lighted.

Who can show me a good human geography of Greece? Perhaps it is now in the making by a member of this association. If there be such a work, should it be possible for a historian of Greece to liken Asia Minor and Egypt to enormous jaws about to swallow Cyprus, to describe the Egean and Adriatic as *fiords,* to liken southern Europe to a mastodon, Greece being a leg; to call Greece with its mountain spurs and bays a skeletonized leaf, to fill the peninsula with tiers, storeys, waists, claws, wheels, threads and tongues, and leave you not knowing whether this poor little country is a house of many rooms or a spider with sprawling limbs. But we are most gravely assured that the geography of Greece had results upon its history, and diversity of states formed by diversity of surface is the lone geographic captive shut up in this dark closet!

If we turn to sociology we meet the insistence on the importance of environment. Let us take Giddings's definition, that

> Sociology is an attempt to account for the origin, growth, structure and activities of society by the operation of physical, vital and psychical causes, working together in the processes of evolution.

Or we may cite the utterance of Small, that "this force is incessant, that it is powerful, that it is a factor which may never be ignored."[7] Yet Dr. Small in an extended chapter on environment mentions geography but once, and then not as a science which might contribute to sociology. Professor Ridgeway[8] thinks that failure fully to recognize man as controlled by the laws of the animal kingdom leads to maladministration of alien races and blunders in social legislation. He says, further, "As physical characteristics are in the main the result of environment, social institutions and religious ideas are no less the product of environment," and again, any attempt to eradicate political and legal institutions of an equatorial race "will be but vain, for these institutions are as much part of the land as are its climate, its soil, its fauna and its flora." Ripley, in reviewing the second volume of Ratzel's anthropogeography, criticizes the author for neglecting acclimatization, considering its importance in social theory, and in view of the fact that theories of race dispersion turn upon our judgment in this matter. Perhaps the real state of the case is seen in the appearance

7 "General Sociology," A. W. Small, 417.

8 Wm. Ridgeway, "The Applications of Zoological Laws to Man," *Brit. Assoc. Ad. Sci.,* Dublin, 1908, 832–847.

not long ago of a serious and careful volume on the development of western civilization, which nevertheless exhibits an utter dearth of geographic data and principles.

We are safe then in saying that most authorities in these sciences of man recognize environment as fundamental, but the greater part, in a sort of absolution of conscience, name the subject and take leave of it.

We need not therefore expect the historians or the sociologists to develop in any full way the principles of environmental action. They admit the need of these principles, but have not the time, perhaps not the will, to develop them. It remains for us to put content into the word environment, so that it can not be overlooked or slighted and so that its meaning may become available in plain terms to all.

In his "Racial Geography of Europe" Ripley asserts that

> To-day geography stands ready to serve as an introduction as well as a corrective to the scientific study of human society.

This was written about twenty years ago, and yet it is to-day not so valid or truthful a statement as we could desire it to be. Our convictions are in the right place and much has been done, but we still suffer from a dearth of limited, local, special and proven data, and a surplus of generalizations announced with the enthusiasm of fresh discovery, or rediscovery, unsupported by adequate evidence. We are subject to Marett's criticism of certain generalizations of Ratzel and La Play—"too pretty to be true."[9] We are awaking to the importance of our field and this is well, but it is equally important to make haste slowly and to give human geography a content satisfying to ourselves and convincing to our fellow workers in adjoining fields.

The pursuit of our theme is as difficult as it is important. Professor Cramb in a recent book[10] comments on the causal idea so common in our modern thought about history. His word is equally good for us. He says:

> In man's history nothing is more difficult than to attain to something like a just conception of a true cause.

Universality and necessity are the criteria which he proposes. A stiff application of these principles would be a tonic for some geographical theorizing.

Here is an individual, X; What is he? He is first a bundle of anatomical characters. How did he get them? Why is he different in these matters from some other man? A single example will show how little we know. Professor Boas well says that "haphazard applications of unproved though possible theories can not serve as proof of the effectiveness of selection or environment in modifying types."[11] He calls for comparison of parents of one environment, with their children reared in another. He has made such investigation upon children of immigrants in New York City and concludes that distinct changes, as of head form, took place.[12] He has done well, no doubt, all that one piece of investigation permitted. But he does not analyze the factors of change nor show what any factor does. Alongside of these apparent changes in one generation we may put an opinion of Professor Myres, who, referring to a common belief that Alpine man originated in the Alpine region in response to environment, states his conviction that the time since the glacial period would not suffice for so great a change of head form.[13]

[9] R. R. Marett, M.A., "Anthropology," 98.

[10] J. A. Cramb, "Germany and England," 113.

[11] F. Boas, "The Mind of Primitive Man," 52.

[12] F. Boas, "Changes in Bodily Form of Descendants of Immigrants," Sen. Doc. No. 208, 61st Cong., 2d Sess., Washington, 1910.

[13] J. L. Myres, "The Alpine Races in Europe," *Geog. Jour.*, 28, 538.

Lester F. Ward is equally confident that

There has been no important organic change in man during historic time.[14]

Our individual also embodies physiological and psychical activities which are affected by environment. Here the problem is immensely involved, for, as Brinton says, psychical development depends less on natural surroundings than on a plexus of relations of each man with many others.

Natural environment includes first the physical—soil, water, minerals, land form, temperature, moisture in the air, light, electricity, and all operative on an earth in interplanetary relation to the sun. Then is added the animal and plant environment whose daily pressure on the individual and the group has held in no small way the destinies of civilization. Interwrought with all these natural forces are the human-social factors ever more powerful since the dawn of history. Thus there is a total of infinitely variable factors producing infinitely diverse results upon the body and mind.

The environment of this day and hour is perplexing enough, but environments change: man exchanges one environment for another. The steady drive of our environment in its daily flux is replaced by the shock of a new environment entered in a day or a night or gained by long voyages across the sea. The sum of a man's heredity goes out into his new sphere with him. But how much of this is primal and persistent and how much can be shifted like a garment? The heredity doctors have not answered this question and geographers should have a care. It is a wholesome corrective to remember the number of our possible ancestors. According to Boas,[15] an Eskimo could not have so many as you or I. Royal families share this limitation with the polar man, and one European monarch, it is said, has in the past twelve generations only the meager oufit of 533 ancestors out of a theoretical 4,096. We, however, belonging to a large population of unstable habits might have in twenty generations more than a million each. We are too complex to come to an easy reckoning about ourselves.

By our social memory we carry the old environment into the new, and thus we "compound"[16] environments, and this ends in making environment coextensive with the world. The universality of modern environment for any civilized man appears in our commercial interchange and speaks to us in a war whose center is in Europe, whose circle takes in the world.

Ratzel in showing how Christianity conquered its realm not as direct from Palestine, but as modified on its way through Egypt, Greece and Rome, has given us a good example of such compounding of environments.[17] Geographers have by no means been blind to the difficulty of anthropic problems. Brunhes warns us that truth in geographic relations of man is approximate, and that to claim it as exact is to be unscientific.[18]

The outstanding psychological fact then is the antithesis of a rigid fatalistic determination of human acts by climate and soil.[19]

And he then cites what he calls "antinomies," frontier, urban, racial and social. Ratzel has a most instructive passage on sources of error due to the neglect of middle members lying between visible workings and their remote causes, the inclination to take a direct line instead of the roundabout way of mediate working causes. This

14 L. F. Ward, "Pure Sociology," 17.

15 F. Boas, "The Mind of Primitive Man," 84–88.

16 R. R. Marett, "Anthropology," 122–23.

17 "Anthropogeographie," I., 175.

18 J. Brunhes, Inaugural lecture, *Scot. Geog. Mag.*, 29, 362–63.

19 *Ibid.*, 367.

leads either to false results or to the hopelessness of reaching the truth.[20]

Professor Myres in the closing lines of his little book, "The Dawn of History," admits and emphasizes the vagueness of results in trying to estimate the relations of history, geography and biology. But his final word is of good cheer,

> If the reader is moved to complain with that other, "I see men as trees walking," let him remember that he who said that, was well on the way to "see every man clearly."

Thus far our notice of our difficulties has been general. Let us look at the questions of race. "Race is the key to history—what is the key to race?" Thus Griffis inscribes the title page to a volume on Japan. In estimating the force of a given environment on a given time how much shall we allow for race? But we must go back of that. How did environment go into the making of race? But suppose we are not sure what a race is and can not with any agreement analyze and classify present races! Authorities agree neither upon race, nor upon the efficiency of race in relation to environment. Thus one authority assigns a race cause for the higher status of long heads as compared with broad heads in certain parts of France. The long heads have more wealth and pay more taxes than their brachycephalic countrymen. Is this really a racial result? Or is it due to a fortunate occupation of richer lands, bringing in its train the higher professional and social status and the urban tendencies of the northern blonds? The criteria of necessity and universality need to be pressed home.

The present writer has difficulty, being a layman, in understanding the ethnologists when they classify races. It is increasing to one's comfort therefore and saving to self-respect to find a member of the anthropological fraternity saying of the development of races that it is "immensely difficult to separate the effects of various factors," and that, "it is not edifying to look at half a dozen books upon the races of mankind, and find half a dozen accounts of their relationships having scarcely a single statement in common. Far better to face the fact that race still baffles us almost completely."[21]

We may add a further observation, that much in this field depends upon paleography, if we are to decipher the origin and migration of races. But here, as Marett says, is a rather kaleidoscopic science, for the continents and bridges which it calls up out of the ocean have a way of crumbling.

Let us illustrate by the so-called Aryan question. It used to be an item in the ethnological creed that most European peoples using languages of cognate features came thither from central Asia by the way of India. But many years ago now it was shown that common language did not prove race kinship. Nor do names of trees and other plants suffice to trace migrations, for men change the names of their trees, and floras migrate in the long marches of time. It has been remarked that if we had no historical knowledge to the contrary, *tobacco* and *potato* might be taken as parts of a European tongue, rather than a loan from the Caribbean natives.

So come the measurer and the calipers in place of the linguist and set up the physical criteria of head form, stature and color, and put in place of a comfortable and discredited generalization the chaos of opinion which is often the precursor to more fixed and defensible conclusions. But such conclusions have not yet been reached. So uncertain is the status of the problem that one writer on the sources of the Germanic invasions says that while some put the origin in Africa, others trace racial dif-

[20] "Anthropogeographie," I., 54.

[21] R. R. Marett, "Anthropology," 61.

ferences to environment and others fall into skepticism about the whole matter.[22] This author thinks the Germans are diverse, as a Roman might be anything from York to New Carthage, Corinth or Damascus.

Brinton holds that the origin of this so-called Indo-European group was in the west, the central Celtic tribes moving from the Atlantic region through the Alps to the Danube, a southern series of offshoots peopling the Mediterranean, and the northern, moving southward and eastward from primitive seats on the North and Baltic seas:[23] Another authority thinks with Sergi and Keane that the Mediterranean stock came from Africa and that the dolicho-blond developed after the passage to Europe and the initiation of the Mediterranean water barrier.[24]

Ridgeway,[25] on the other hand, makes two non-Aryan races in Europe, Alpine and Neolithic, overrun by two Aryan races, once thought to have come from Hindu Kush, now believed to have originated in upper central Europe. He argues that to follow Sergi in making the Mediterranean race non-Aryan "leaves out of sight the effects of environment in changing racial types, and that too in no long time." He cites the cases of the Boers in Africa and of New World natives changing their latitude. There was gradual change from the short, dark men of southern Europe to the tall blonds of the Baltic. This means more than intercrossing and raises suspicions of constantly working climatic influence. He thinks environment the chief factor in stature and pigmentation. Attention to other animals, in Ridgeway's view, demonstrates this doctrine. He cites the white hares and bears and the tendency of the ptarmigan and the horse to turn white in winter. The horse is cited as shown in varieties from northern Asia to the Cape of Good Hope, and this writer concludes that environment is powerful not only in colorations, but in osteology, and that these changes may be very rapid. The blond Berbers are believed to owe their qualities not to mixing with Vandals and Goths, but to being cradled in a cool mountain region. The fair-haired people have poured for centuries across the Alps and yet hold their own only in the north of Italy. Woodruff does not think they were darkened, but that natural selection eliminated them because they went beyond their latitude range. *Homo Alpinus* is held by different authors as Aryan or as Mongolian from Asia, and as having evolved their brachycephalic character on European soil.

Marett, referring to Ridgeway, thinks he overrates environment, but admits it as premature to affirm or deny that in the *very long run*, round-headedness goes with a mountain life.[26]

To add other items of opinion, confirming the conviction that much fruit has set, but few specimens have ripened, Marett places in north Africa the "original hot-bed"[27] of the Mediterranean race, who in Neolithic times colonized the north shore of the Mediterranean and passed by the warm Atlantic as far as Scotland. The same author, keeping close to cover, says that it is now fashionable to place the Teutonic home in northeastern Europe, though he regards it as still something of a mystery. The Scandinavian origin of Euro-

22 C. H. Hayes, "Sources of the Germanic Invasions," Studies in Hist. and Pub. Law, XXXIII., 14–15.

23 D. G. Brinton, "Races and Peoples," 151–52.

24 "The Mutation Theory and the Blond Race," *Jour. Race Devel.*, III., 491–95.

25 Wm. Ridgeway, President's Address, Brit. Assoc. Ad. Sci., Dublin, 1908, 832–47.

26 Marett, "Anthropology," 107.

27 *Ibid.*, 104.

pean peoples is held by some[28] while J. L. Myres shows the affinity of boreal and Mediterranean man and suggests their Euro-African origin,[29] and Gray's discussion of Myres's paper emphasizes the swift action of environment.[30]

Altogether it is hardly to exaggerate to say that you can find authority for placing the breeding grounds of the European peoples in north Africa, in central Asia, or in any part of Europe, for sending their wandering progeny in any direction of the compass, with any kind of racial mixture or linguistic evolution and with every possible shade of efficiency or inefficiency on the part of environment.

But suppose the Aryan business cleared up, there would remain earlier problems of Paleolithic differentiation and the prolonged twilight journey of man. And suppose we had threaded our way, geological, ethnographical, linguistic, and geographic, down through the differentiations and mixtures and migrations until we have the Teuton and the Celt in north Europe and the British Isles, are our troubles past? Let us see.

You would trace the evolution of the American, as effected by environment. Where will you begin? Not in New England or Virginia. Not altogether in old England. Not altogether in Teutonic Europe. Before we got through with the American we might like to cover all Europe with the network of our inquiry. But we can not move too broadly; let us turn to the British Isles. There are still the progeny of the pre-Celts of Neolithic age. There came at least three types of Celt, the Gael, the Briton and the Belgæ. Roman invasion and rule followed and in due time the Christian religion. Next came the Angles and Saxons and Jutes from across the North Sea, a new deluge of paganism, and a new contribution of racial traits bred in the long past. One would like to know how that old North Sea Teuton differed, fifteen centuries ago, from the Baltic Sea Teuton of the Prussian plain. Was it in the latter's great strain of Slavic blood, or were there other factors. When and where did the present sum of difference between Prussian and Englishman begin to emerge? At any rate, Jutland, Schleswig-Holstein and the lowlands of the Elbe were poured into our ancestry and were Christianized.

In the eighth century the Viking rovers came across the North Sea, with fresh cargoes of vigor and paganism. The Rhine, Scheldt, Seine and Loire as well as Britain felt their power. "From the fury of the Northmen, save us, Lord," runs an old litany. But pirate and robber though he was, here was an element of selection that must not be disregarded. Norway, Sweden and Denmark, says Greene, "were being brought at this time into more settled order by a series of great sovereigns, and the bolder spirits who would not submit to their rule were driven into the seas and embraced a life of piracy and war." But there had been bred into them "in a land that is one third water and one third mountain, where winter lasts six months in the year, endurance, ingenuity and daring."

In two or three centuries more followed the Norman Conquest, in which the Viking brought to England all that he had taken on and taken in of French life. There follows the further coordination of Neolithic, Celtic, Teutonic and Norse men for five and a half centuries, until the early decades of the seventeenth century and the beginnings of British settlement in America. And this was a selective migration whose story can

28 Richard, "History of German Civilization," Ch. II.

29 J. L. Myres, "The Alpine Races in Europe," *Geog. Jour.*, 28, 537.

30 *Ibid.*, 555–56.

not be told here, and has never been so fully told as the student of environment might desire. Suffice it to add that no mere paragraph can tell us what kind of people came to Massachusetts, or Virginia. Religious, economic and political changes in England, plus the attractions of a fresh world, brought across the sea the elements that have been formative in American life. American environment has not developed all the qualities which we consider as distinctively or typically American.

But in New England, and on the Hudson, the Delaware and the James, new physical and social pressures began to wield their power. After some generations in this environment in the eighteenth century, a new flow began through the passes of the Appalachians. To Timothy Dwight is ascribed the view that thus New England was rid of her restless and insubordinate spirits. Another interpretation is that the best and most progressive men went because they did not like the rule of the Congregational clergy. At any rate, it was another selective migration, by which picked families went into a new environment. Turner is our best authority for what the environment of the middle west made out of the emigrant from the East. It would be easy to show, I think, that in spite of what might seem predominating mixtures of Continental European migration, New England still pervades Wisconsin, that the New England mind was more powerful than the new environment, important as that was, just as the Puritan mind was more powerful than the New England environment.

The selective emigration moved on by prairie schooner and transcontinental railway to the Rocky Mountains, the intermont plateaus and the Pacific Coast. Here are mountains, deserts, mines, giant forests, irrigation and a new ocean. Whence came the Californian? From New England, Ohio, Iowa, Kansas, Colorado. Is that all? Every one of the following regions is there, with 5,000 to 200,000 representatives. Germany, Ireland, England, Canada, Italy, Mexico, Russia, Scotland, Sweden, Switzerland, Portugal, Norway, France, Denmark, Austria, Wales, Turkey, Spain, Greece, China, islands of the Atlantic, Australia. The German, Canadian, Englishman, Spaniard and Russian that wanted to be or do something new are there. And it is a compelling environment, of sky and mountain, ocean and plain, forest and desert, mine and field. Professor Royce, a native Californian, thinks the typical character there is a combination of strength and weakness, with wandering in the blood, lack of social responsibility, recognition of no barriers, desire for sudden wealth, love of difficulty, unaccented love of home, with more love of fullness of life than reverence for the relations of life.[31]

One more picture of this western life must here suffice—it is by a journalist—of the American of the far northwest, where New England and the *Mayflower* appear not, whose men followed the Missouri from Kentucky, Indiana, Missouri and Arkansas, tall, big-boned, and stalwart, self-assertive, nervous, quick in action, acting before they think and thinking mainly of themselves, their European origin so far behind them that they know nothing of it. Their grandfathers had forgotten it. In a word they are distinctly, decidedly, pugnaciously and absolutely American.[32] Making what allowance you will for Ralph's exuberant rhetoric, and Royce's habit of philosophizing, better to be solved in the twenty-first century than to-day is the

[31] J. Royce, "California," Am. Com. Series, 499–500.

[32] J. Ralph, "Our Great West," 141–42, quoted in abstract.

problem of the function of environment in shaping American life. As we have seen in this sketch, the geographer will not work alone, the historian, sociologist and philosopher will take a hand.

It's a long way from the primitive man to the differentiation of the white race, from the white beginnings to Briton, Anglia, Norway and Normandy, from Anglia and England to California and Puget Sound. Along this ancient and devious path our ignorance of the inner laws of human development is appalling. We see man, and earth, something called race, race continuity, one physical environment after another, human environments with innumerable mixtures of blood, in infinitely various compounds, in the grand march of humanity to one world center after another. The result, to carry out our illustration still, is the Pacific coast man, domestic, industrial, political, social, moral. It will take cautious steps and many torches to pick our way back along the road by which he came.

Let us take another example in emphasis of the difficulties which beset us—an analysis of the causes of Japanese character. Mental alertness has been asserted to be the chief trait of the Japanese. This must have originated in accordance with biological laws, in spontaneous variation, in mixture of races, or in environment, or we might add, by a combination of these. It is tentatively held that however this quality arose, it has been preserved by environment: first, by insularity, giving familiarity with the sea, saving from wars, intermixtures and invasions, in distinction from a continental land, like China; second, by physical features, affording small areas of cultivation, promoting industry, a land of such richness as to give certainty of reward, without drought or flood to destroy the prudent as well as the thriftless. Third, there comes climate, following a supposed law that the progressive lands are in the cyclonic domain of the Temperate zone.

This seems simple, interesting and suggestive, but is it true? Is mental alertness the chief trait in Japanese efficiency? Droppers, sometime professor in the University of Tokyo, thinks the secret of success is in the structure of society, devotion to family life, or to tribe and nation, the corporate versus the individualistic.[33] Dyer emphasizes community but denies that the main ability is in imitation. Loyalty and intellectual ability are the basis of achievement. Another authority marks the Japanese as sober, intelligent, enduring, patient, industrious, polite, skilful, ready to assimilate, not devoid of original genius.[34] Yet another says he is patient, persistent, cheerful, versatile, quick-witted, enterprising, original, imitative, progressive, industrious, artistic, humorous, cleanly, polite, honorable, brave, kind, calm, self-contained.[35] Whether any good human qualities have been left out of these catalogues, we do not know, but we are at least left in doubt as to what the main national trait is.

But suppose it is mental alertness. Would insularity make it or keep it? Miss Semple avers that insularity breeds conservatism, a quality that does not seem to be indissolubly tied to alertness. Insularity may give familiarity with the sea, but perhaps not greater than is true of the Dutch, who are not insular, and we do not think of the Dutch as distinctively alert. Insularity has not kept Japan free from invasion, though there have been periods of seclusion. And the modern Japanese are

33 Garrett Droppers, "The Secret of Japanese Success," *Jour. Race Devel.*, II., 424.

34 V. Dingelstedt, "Ruling Nations," *Scot. Geog. Mag.*, 27, 305.

35 Writer in New Inter. Ency., Art. "Japan," 335.

"a very mixed people," Mongolian, Caucasian, Malay, and some say an infiltration of Negrito. If insularity breeds alertness, what other factors have apparently swamped this tendency in Madagascar, Iceland, Sicily, Cuba and Hawaii?

Nor can we be sure of the effect of small areas of rich cultivation and certain reward. Industry we can predict and a degree of comfort, but can we say more? Why not as well expect the Belgian farmer or the farmer of the Paris basin, or of the county of Norfolk to be mentally alert? Moreover, most Japanese are in a low state. "We imagine them" (the Japanese) "as intellectually homogeneous," but there are "five million highly cultivated people and nine times as many of lower type . . . the mighty mass still pagan, stolid, low in the scale of evolution."[36]

This little empire is indeed a good place in the temperate zone, and so are China, Switzerland, Spain, Austria-Hungary, Germany, France, and too many others to make the criterion of distinctive value. The inference for precise, detailed and prolonged research need not be elaborated.

We have already spoken of certain related sciences as supplying motives to the human geographer. We turn now to examine the geographer's proper sphere of activity in relation to these sciences.

Our references to the race problem might seem superfluous, for if this field belongs essentially to the anthropologists, what right has the geographer there? Here we seem at once to need a definition of geography. But the present writer will not try to go where angels have trod with devious and faltering steps. Some time we shall have a definition of geography, but not now. Meanwhile we have enough to do, and if we are reviled as devotees of patchwork, as having no real science, we bear it with serenity.

I do not know of any one who proposes to rule us out of the human sphere and shut us up to the physical. If I can get my foot on what Brunhes calls the "Humanized surface"[37] of our planet, I am content. I shall have enough to do without quarreling with my neighbor, or resenting anything he may say to me. Brunhes also says that we are where roads meet, with facts from many sources, that we must not be a bazaar for retailing everything, but have our own domain and commit no trespasses. What the limits of this field are is not so clear, but why trouble about it, when no science has a fenced domain?

Ratzel makes a sweeping criticism of Buckle when he says that *evolution* is unspoken by him.[38] The great geographical philosopher of Leipzig made it forever imperative for us to "go back into the past." He speaks of differentiation, of bequeathed influences, of the migration of developed traits—he never lets you doubt that he is moving into the realm of Darwin. So the geographer, if he touches man at all, and the more if he opens the question of geographic influence, must be in daily contact with the principles of biological evolution, so far as the specialists have mastered them. I will not try to say how far he may supply useful data to the biologist; sure it is that human anatomy, physiology and psychology must be relied upon for light on the early (as well as late) stages of mankind. Should not this field be turned over to the anthropologist?

The first answer is that so far as environmental factors are concerned, the geographer alone is responsible for the knowledge of the total physical complex which the earth affords. But when this compre-

[36] W. E. Griffis, "The Japanese Nation in Evolution," 271, 386, 389–90.

[37] J. Brunhes, *Scot. Geog. Mag.*, 29, 313.

[38] "Anthropogeographie," I., 97–98.

hensive survey of the physical geography has been supplied, do not the geographer's duties, and even his rights, cease? If so, and if we must leave the action of environment to the anthropologist, to what kind of an anthropologist? The somatologist perhaps. The somatologist studies the natural history of the body. This is highly important, but it is only one point of view. He also studies man in his physiological development, but this is also partial. Your anthropologist may be primarily a psychologist, a philologist, or a student of early arts or of comparative religion. Or he may be an ethnologist studying the physical features, mental traits, linguistics, practical arts, legends and religions of a single tribe or people.

To which one of these will you look for a world view of the influence of environment on early or half-developed man? For your answer go through all the reports and books of the anthropologists, rich as they are, and tell me the result. In the nature of the case, the anthropologist, even if he could command all the departments of his own science, is not in a position to organize the principles of the influence of an earthwide environment on man. He offers indispensable materials and he may find other unities in his field but the inclusive bond of world environment belongs to the geographer.

Suppose we say that we do not need anthropologists because there are anatomists, physiologists, psychologists, philologists and students of art and religion. The answer is that anthropology aims at the natural history of man as a whole. The specialists work indeed too often in small and isolated fields and not always with the causal and comparative principle in full view. But man, the bond, is there, and the science receives its justification. In like manner, why should there be geographers, for there are geologists, meteorologists, oceanographers, astronomers, botanists and zoologists? We say because there is no other to organize the data of all these sciences in relation to the whole earth, as we see it and know it.

Taking the like case—there are anthropologists of many sorts, historians of several kinds, sociologists, economists and technologists in ample variety. Why a human geographer? Because there is no other to exhibit the human kind (not now but in some coming day) in its causal and distributional relation to the earth and its forces viewed as a unity.

Professor Adams in his presidential address before the American Historical Association manifests a little concern because of the entrance of political science, geography, sociology and certain other subjects into the arena.[39] But history, conceived on the modern scientific basis, opens so vast a field that collaborating sciences may well be welcome in the task. Equally may the geographer rejoice that every science of man contributes to his own and that he in turn has something to share.

There need be no hoarding of opportunity, where opportunity is infinite and no quarreling over line fences where none can exist. Professor Turner, referring to economist, geographer, sociologist and other fellow-workers, has thus broadly expressed the true attitude of the historian:

> The historian must so far familiarize himself with the training of his sister subjects that he can at least avail himself of their results and in some reasonable degree master the essential tools of their trade.

No one would accuse Professor Turner of advising over-expansion or superficial endeavor, but he seems to think it possible to be a historian and something more, by virtue of which to be a better historian. So say we of the geographer. Let him be

[39] *Am. Hist. Rev.*, Vol. 14.

"familiar with the whole earth," as demanded by Ratzel,[40] not in detail, but broadly familiar with causal principles and their regional illustration. Then let him know the methods and results of history, or of sociology, or of anthropology, or of some phase of one of these. Then he can cooperate in that study of environmental influence which must be common ground for all.

All this has its bearing on the higher education, for every human geographer should have his minor studies in some other science of man, and no young historian should be allowed to escape who is not grounded in the principles of physical geography and who has not looked through the geographer's eye at the impress made by nature on man.

Sociology is a science which equally with geography has aroused skepticism concerning its right to be called a science. Be that as it may, its devotees occupy ground which stretches into historical territory, on the one hand, and geographical and anthropological on the other. This is conceded by Small.

The comprehensive science has the task of organizing details which may already have been studied separately by several varieties of scholars.[41]

The same author sets forth the influence of nature with an emphasis which if used by the geographer might call down a charge of excessive claim.

Nature sets our tasks, and doles out our wages, and prescribes our working hours and tells us when and how much we may play or learn or fight or pray. Life is an affair of adjusting ourselves to material, matter-of-fact, inexorable nature.[42]

Small does not think we yet have an adequate story of the operation of cosmic laws in determining the course of human development.

Mr. E. C. Hayes, in a paper in the *American Journal of Sociology*,[43] discusses the relation of geography to sociology and the definition and scope of geography. He seems disposed to think that stating the effects of geographic conditions on social phenomena will be an integral part of sociology, but thinks

it will still remain true that no science but geography describes the regions of the earth by bringing together into one description all the various facts separately studied by the different sciences.[44]

It is fair to say that only the geographer can know the physical conditions in a broad and deep way. It is just as fair to expect the sociologist to be superior in the strictly human field. But neither can dismiss the other, nor prescribe a legitimate boundary line of research. And there is always the possibility of a genius equally at home in both fields, scorning all petty frontiers of our so-called sciences, fusing and recreating the data and conclusions of lesser men, and recording for all time those large generalizations of which we dream and for which we strive.

After all that can be said on the relations of geography to other subjects, I am content to come back to a confessedly general, but safe and truthful word by James Bryce.

Geography is the point of contact between the sciences of nature taken all together and the branches of inquiry which deal with man and his institutions.

I think it is a sociologist, Ward, who likens the progress of science to the progress of a prairie fire. No doubt he means that it moves irregularly but surely. The figure is not altogether good, as indeed no figure is, for we do not move with a rush, neither

40 "Studies in Political Areas," *Am. Jour. Soc.*, 3, 302.

41 A. W. Small, "General Sociology," 7.

42 *Ibid.*, 408.

43 Vol. 14, 371–407.

44 *Ibid.*, 400.

does our going leave a zone of destruction behind. Our work is constructive and slow. Whether the worker be a geographer or bear some longer name, is not material. If he have no name at all, let us accept his fact, his principle, in good faith that as workers and half-thoughts come and go, the body of truth gathers volume, order and power.

We come now to the last phase of our discussion, the most important and difficult of all—lines of investigation. What is our present status? It would be a good work if some one would review historically the progress of the idea of environmental influence. Here the barest sketch must be the preliminary to our inquiry.

We may pass by the fragmental notices of ancient and medieval writers. Modern seed thoughts are not uncommon, and some harvest could be gathered from the philosophers and literary writers, Hobbes, Montesquieu, Kant, Herder, Hegel, Comte, Taine, and others. Humboldt, Ritter and Guyot laid the foundations of our modern human geography, and then came Darwin, pointing the road to fruitful study for all the sciences of organic nature and of man. Ratzel, in the spirit of Darwin, kept the unfolding of geography abreast of the progress of anthropology, history and other human sciences in the last half century, and now Miss Semple has placed all geographers in her debt in the expansion and precision which she has added to the work of Ratzel.

General works of lesser scope, some of them regional, have appeared in this country and in Europe. Mackinder, Herbertson, Lyde, Chisholm, and others in Great Britain, and Vidal la Blache, Brunhes, Partsch, Penck and many others on the continent, have made important contributions. Already we have a large and rapidly growing list of small monographs dealing with limited phases or regions in this country. In America this work is largely the achievement, direct and indirect, of the members of this association, and the present program is sharp evidence of the force of an impulse that has gathered power among us during the ten years of our cooperative endeavor.

My first hint is in the direction of climatology in its relation to man.[45] Here is a new science, with a growing body of observation, generalization and record, made available in description and in maps. Climatology is beginning to be appreciated in relation to other fields of physical geography. We begin to value and to express in text-books the relation of the atmosphere to the origin of land surfaces, glaciers, aridity and the waves and currents of the sea. We see its functions also in relation to the mineral contents of the earth, and in relation to the origin and use of soil.

Even more pronounced is the growth of ideas in relating the atmosphere to fauna and flora, to plant and animal types and societies, to bacteria, and to forests, steppes and deserts. Involved in all this relation to the inorganic and organic world is an immense indirect influence on man.

There is also direct influence on man, through temperature, varying constitution, variations of pressure, moisture content, movements, optical effects and sound waves. And we can not stop short of psychical, social and economic phases of influence, all tangled in difficult fashion. When the consumptive goes to Colorado for help, and finds it, what has accomplished the result? Is it rarity and increased lung expansion? Is dryness and a non-relaxing quality uppermost? And how much is due to new hope, new effort, fresh scenery, new and glorious land forms, clear skies, gray desert and new social environment? Let

[45] J. Brunhes, *Scot. Geog. Mag.*, 29, 312; C. R. Dryer, *Jour. Geog.*, Feb., 1913, 178; Ratzel, ''Anthropogeographie,'' I., Ch. Das Klima.

us move, but move cautiously, heeding Professor Ward's emphasis on doubtful elements in the relation of climate to disease. Perhaps there is no subject, unless it be politics, on which men say so much and know so little as about climate.

Geography has a considerable body of good knowledge of climate in relation to modes of living in typical parts of the world. We know that the Eskimo is carnivorous, the tropical savage vegetarian and that the denizen of temperate latitudes brings both foods to his table. We know the climatic results in clothing and shelter, in nomadic and pastoral, agricultural and static life, and among hunters of the forest. These are all important, but more or less indirect climatic effects, so well set forth by Herbertson in "Man and His Work."

But what of direct effects of climate? I hesitate to use the word direct of such activity. Such is our ignorance of the precise efficiency of these forces, that apparent direct agents may turn out to be mediate, after all.

How much exact knowledge have we in the field of coloration? Grant that this is mainly a physiological problem, so far as man is concerned, will it ever be solved, and the results broadly stated except in collaboration with geography?

> Color almost certainly developed in strict relation to climate. Right away in the back ages we must place the race-making epoch, when the chief bodily differences, including differences in color, arose amongst men.

This is from Marett and he adds that natural selection had a clear field with the body before mind became the chief factor in survival.

Now, how much is definite here? What is this "strict relation" to climate? And what element of climate does the work? Is it heat, or light, or moisture, or a combination of these? What does each climatic factor do, and does it do what it does, independently, or by the aid of some non-climatic factor? Why is the Malay brown, the Chinaman yellow, the American Indian coppery and the negro black? And how do the osteological features and the facial features correlate, if at all, in origin, with the color? Here is a vast field. What, of assured answer, is on record?

Brinton says that climate and food supply are the main causes of the fixation of ethnic traits. He adds that temperature, humidity and other factors bear directly on the relative activity of lungs, heart, liver and skin. This seems to come near to the core of things, but no precision is reached and I suppose can not be in the present state of knowledge. Ratzel was not wrong in citing the negro's dark skin as illustration of the fact that the search for causes goes after hard and deep-rooted things.

The study of the races of Europe teems with conjectures about blonde and brunette, but the physiological basis is wanting. We should like to know whether the Mediterranean longhead is a darkened Teuton, or whether the Teuton is a bleached African. Here is joint work for physiologist, anthropologist and geographer.

Ward notes the fading of hair, beards and skins of polar explorers.[46] The same author, leaving open the origin of color, quotes Darwin on the accumulation of color through natural selection and contents himself with the assured fact that color, however obtained, is an advantage in a hot climate. This field therefore is almost unworked. I hesitate to say that the door for research is wide open, but one would hesitate even more to believe that the problem can not be solved.

Suppose now we leave these primitive and racial puzzles and come down to possible effects of climate that can be seen and registered in a few generations, if there be

[46] R. DeC. Ward, "Climate, Considered Especially in Relation to Man," 216.

such effects. Here is the question of acclimatization and tropical disease, in short, of the white man's burden.

Here again Ward proceeds with instructive caution. It is a complex subject, he says, conclusions are contradictory, curves may be made to show anything. There are many weather elements and there are many other factors, such as sanitation, foods, water, habits, altitude, soil, race, traffic and other controls. Microorganisms intervene to make climate largely an indirect influence.[47]

Thus we have a group of problems for the medical observer, but either in him or with him must the geographer share the task whose successful accomplishment affects the destinies of every colonial empire and the ultimate place of the white race. Brinton speaks of the hopelessness of the problem,[48] and Ripley recognizes the importance of it by criticizing Ratzel for inadequate attention to it in the second volume of the "Anthropology."[49] We have an interesting discussion in Woodruff's "Effects of Tropical Light on White Men." It is for a more competent hand to estimate its value. Some of its generalizations seem too sweeping and too easy to be true. Altogether in this whole field, a field of high practical importance, there has been much sincere effort, but no great harvest.

We want narrower fields of investigation and better proven results. Only thus will be gathered the data for great generalizations. In this direction we may cite a passage of Hahn on the physiological effects of diminished pressure,[50] and the studies of E. G. Dexter and H. H. Clayton on the sociological effects of climate.

Let us look at the field of biogeography in relation to man. *The distribution of plants and animals as forming large elements* in environment can not fail to involve man and to uncover many interesting relationships. This study is now in a hopeful state of vitality and progress. Our own association has a good number of workers in this field.

A wealth of pertinent facts awaits discovery and coordination as regards the coincident distribution of man with plants and animals. Payne, in the history of early America already cited, uses this as a basal principle, showing the migration and presence of organic forms in causal relation to man. Here again, Ripley finds occasion to criticize Ratzel for insufficient attention to the theme. A few suggestive illustrations may be given. Kirchoff in his "Man and Earth"[51] coordinates the Mediterranean spread of the Phœnicians with the occurrence of the dye-yielding mollusc. Dr. C. Hart Merriam once surprised the writer by saying that the beaver was the most important fact in early American history. The more one considers this the less one is disposed to consider it as an outburst of a biologist's enthusiasm.

In Hansa days tens of thousands of people dwelt in the Peninsula of Schonen, in the towns of Falsterbo and Skänor, at the most southwestern tip of Sweden. To-day an old church, a few cottages and a summer hotel make up Falsterbo, while Skänor is a sleepy village of a few hundred people. Why should this throbbing Baltic market of centuries ago have suddenly declined to insignificant shore villages? Because the herring migrated to other waters. A new harbor has been built at Skänor and it will be seen whether modern conditions can restore the prosperity which the runaway fish destroyed.

Dr. Scharfetter in a work on the dis-

47 "Climate," 180 et seq.

48 D. G. Brinton, "Races and Peoples," 278–83.

49 W. G. Ripley, *Pol. Sci. Quar.*, IX., 323.

50 J. Hahn, "Handbook of Climatology," trans. by Ward, 224 et seq.

51 Trans. of "Mensch und Erde," 30–31.

tribution of plants and man sets the *Roman boundary in Germany at the edge* of the Franconian forest and cites the fact that the Arabs went wherever the date palm would grow.[52] The practical biologist, such as the agricultural explorer, turns the problem around, shows how to control the distribution of lower life and thus to modify the distribution of man.

Such results must flow from the work of the department of botanical research of the Carnegie Institution, and Dr. McDougal of the Desert Laboratory well sets forth the interrelations of the sciences when he likens the work to the making of a cantilever bridge whose further ends may rest on chemical, physical, geological or geographical piers.[53] A good illustration of this finds immediate place in the investigations by Professor Huntington, in western forests, of climatic events.

The climatologist asks for definite climatic effects on man. The ethnologist or sociologist finds traits in man which might have a climatic origin. The geographer wants all that all types of specialists can give him, both in the physical and psychical spheres. Thus we may approach from the point of view of causes or of results and follow down or up the stream of effects.

We have made a hasty survey of two fields of causation, the one physical, the other organic. Let us turn to certain groups of phenomena in the realm of effects or results. The most important and surely the most baffling problems here are in the psychic field. Here the geographer will be peculiarly dependent on workers in sister sciences and the gap may be hard to bridge. Geographers are not as a rule specialists in psychology, and there is no reason to believe that many students in psychic fields are specially versed in geography. If we can offer a stimulus which shall lead these *kinds of scholars to struggle up the stream* of causality, it may be safer than for us to drift down through rapids and among rocks. But the work ought to be done, and the geographer can at least show its worth and encourage the doing of it.

In this research we are not to think that the earth was all powerful with early man, but is helpless to-day. Color or other race features may have been fixed, but this is not all. If there is something in man that is found in every man, wherever he is, he is not thereby released from the pressure of environment. Psychic reaction on nature does not destroy nature's efficiency, but in a degree directs, refines and uses it. When Professor Lester F. Ward says that "the environment transforms the animal, while man transforms the environment,"[54] he utters but a partial truth. Perhaps he was attracted by rhetorical form, for in a later passage he recovers himself, recognizing the psychic effects of environment, for,

> Courage, love of liberty, industry and thrift, ingenuity and intelligence, are all developed by contact with restraining influences adapted to stimulating them and not so severe as to check their growth.[55]

If a hard winter is a "great Teutonic institution," if rains, dark skies and winter have made more serious peoples in the north of Europe than are found along the Mediterranean, if Geikie rightly ascribes the heart of Ossian's poems to nature in the West Highlands,[56] these qualities of environment are pressing on the human spirit to-day as in Neolithic or Celtic time, moderated, perhaps, by modern skill in getting protection from nature, and by greater contact with all the world. We will not deny the assertion of Thomas that "the force of climate and geography is greater in the

52 Paper is noticed, *Scot. Geog. Mag.*, Vol. 27, 39–41.

53 An. Rep. of Director, 1912.

54 L. F. Ward, "Pure Sociology," 16.

55 *Ibid.*, 58.

56 A. Geikie, "Scenery of Scotland," 407–08.

lower stages of culture and that ideas play an increasing rôle," but we do not know on what ground he makes the further claim that the peculiar cultures of Japan, China and India were in the first place the results of psychic rather than geographic factors.[57]

There is a beautiful passage in Ratzel which I now commend to those historical and sociological philosophers who think that psychic qualities and powers are released from environmental influence. If ethnographers utter the view that the development of culture consists in ever wider release from nature, we may emphasize that the difference between nature and culture folk is to be sought not in degree, but in the kind of this connection (Zusammenhang) with nature. Culture is freedom from nature not in the sense of complete release, but in that of much wider union. The farmer who gathers his corn in the barn is really as dependent on his ground as the Indian who harvests in swamps wild rice which he did not sow.

> We do not on the whole become freer from nature while we deeply exploit and study it, we only make ouselves in single cases independent of it, while we multiply the bonds.

Not to do Ratzel injustice, it is he who has also called "the spirit of man a completely new phenomenon upon our planet," and has asserted that

> No other being (Wesen) has worked so permanently and upon so many other existences as man, who has profoundly changed the living face of the earth.

We are to interpret cautiously similar human phenomena in different parts of the world. We can not here follow the evolutionary axiom that if a species of trilobite is found in England and in New York, there has been one point of origin and a migration. The same things appear in many places, either through the unity of the human spirit or the likeness of environments, or from both causes. This is stated by Fewkes,

> Identity in the working of the human mind is recognized by all anthropologists, and the tendency to ascribe cultural identities . . . to contact or migration is much less prevalent now than formerly.[58]

In like manner Boas shows that some ideas are so general that they could not have been diffused historically through migration and contact, but must have arisen independently in different places.[59]

Tylor is no less emphatic:

> Researches undertaken all over the globe have shown the necessity of abandoning the old theory that a similarity of customs and superstitions, of arts and crafts, justifies the assumption of a remote relationship if not an identity of origin between races . . . there has been an inherent tendency in man, allowing for difference of climate and natural surroundings, to develop culture by the same stages and in the same way.

Citing the pyramid-building of Aztec and Egyptian,

> Each race developed the idea of a pyramid tomb through that psychological similarity which is as much a characteristic of the species man as his physique.[60]

We leave this topic with the single suggestion that in the psychic field, a useful and difficult piece of research is open to the student of comparative religions, who is at the same time interested in anthropogeographic problems and has the needed geographic training. How far the essential content of religious aspiration and thought, as well as the ritual of worship has been influenced by environment, has, I think, never been shown in any full synthetic

[57] W. I. Thomas, "Source Book for Social Origins," 130–31.

[58] J. W. Fewkes, "Climate and Cult," 8th Inter. Geog. Cong., 670.

[59] F. Boas, "The Mind of Primitive Man," 151–64.

[60] E. B. Tylor, Ency. Brit., Art. "Anthropology."

way. It is a task of no common difficulty, not to be lightly undertaken, but worth the doing.

Another field of effects, much more accessible to the pure geographer is the distribution of population studied in the causal way. Enough practise in statistical method for this inquiry can be readily acquired and the results should be most fruitful. Jefferson's recent papers have been suggestive in this field of research, which involves in intimate combinations, physical, economic, racial and social conditions. Akin to this study is the classification of towns and cities, developing the principles of origin, growth and differentiation, as in a recent valuable paper of Chisholm. The city as a geographic organism may be freely taken as an inexhaustible theme.

Another great sphere lies in regional studies, such as states, physiographic units, and countries. The number of such studies, maturely developed, now available may perhaps be counted on the fingers of one's hands. The aim should be not alone directed upon the more obvious matters of route and industry, but also upon deep and underlying principles. What rich and alluring subjects for the intensive student would the state of Pennsylvania offer, of Kentucky, Minnesota or California! Who will develop for us our coastal plain or piedmont, treating town sites, roads, soils, crops, industries, racial composition and social status? Who will do a like work for the great Appalachian Valley, that magnificent and little understood unit of our east—its trails and roads, its agriculture, towns, migrations and historical significance in colonial and current life? There is room for more such studies as those of Whitbeck upon glacial and nonglacial Wisconsin and of von Engeln on the effects of glaciation upon agriculture.[61] The latter, indeed, is not regional except as it naturally deals largely with principles as illustrated in our own country.

Will Mr. Mackinder, or some one else, take up Great Britain, omitting the purely descriptive, as he could not in Britain and British seas properly do, and discuss more fully questions of geographic influence as regards agricultural distribution, the localization of industries, the distribution of population in general, and the effect of various factors such as insularity, climate and world position in the development of British character, British political unity, and British social conditions.

Or in the United States, there are racial compositions, new physical environments, offering new social and economic conditions to population groups as seen in comparison with conditions in the parent lands of Europe. Finally, there are innumerable beckoning fields, of a small and local sort, out of whose diligent study general principles will rise and become established.

Our goal is broad generalization. But the formulation of general laws is difficult and the results insecure until we have a body of concrete and detailed observations. Quoting Brunhes,

> We must then make up our minds to put aside generalities and vague analogies between nature and man. We must make it our business to search for facts of interaction.[62]

From Boas also,

> It goes without saying that haphazard application of unproven though possible theories will not serve as proof of the effectiveness of selection or environment in modifying types.[63]

Detailed investigation of single problems, in small and seemingly unimportant

[61] O. D. von Engeln, "Effects of Continental Glaciation on Agriculture," *Bull. Am. Geog. Soc.*, XLVI., 241–64, 336–55.

[62] J. Brunhes, *Scot. Geog. Mag.*, 29, 311.

[63] F. Boas, "The Mind of Primitive Man," 51.

fields, must for a long time prepare the way for the formulation of richer and more fundamental conclusions and general principles than we have yet been able to achieve. We should not wait for some one to state or demonstrate these laws. This is yet, even for a genius, impossible. We must contribute in partial, microscopic, sometimes unconscious ways to the emergence of such laws.

Professor Adams, speaking of the available and most useful tasks of the historian, has a word which is equally good for us,

> To furnish materials, to do preliminary work, is to make a better contribution to the final science than to yield to the allurements of speculation, to endeavor to discover in the present state of our knowledge the forces that control society, or to formulate the laws of their action.[64]

Not only is this a model principle, but it emphasizes the value of our goal, for the real philosophy of history will not be written until geographic factors have had broader and deeper recognition. Here I do not speak as a geographic enthusiast, nor in denial of the supremacy of the human spirit.

Such then is the mode of advance of our science—the old story of interest, hypothesis, test, correction, publication, criticism, revision; progress by error, by half truth, by zigzag, spiral and apparent retrograde; by aero-flight, by patient tunneling; some at the salients of progress, and some in the ranks of humble endeavor, the goal in front of all.

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LEWIS LINDSEY DYCHE

Lewis Lindsey Dyche, professor of systematic zoology and curator of the collections of mammals, birds and fishes, at the University of Kansas, died in Topeka, Kansas, Wednesday, January 20, 1915. Professor Dyche was intimately associated with the life of the university for nearly thirty-eight years, having seen nearly every class graduated from the institution. His first connection with it was as a student in the preparatory department. He entered the middle class of the preparatory department in September, 1877, at the age of twenty years, being registered from Auburn, Kansas. James Marvin was then chancellor of the university. There were 12 members of the faculty and a total attendance of students of 361, of whom 110 were of college grade. Mr. Dyche finished the senior preparatory work at the end of the next year and in September, 1879, became a freshman in the collegiate department, enrolling as a student in the classical course. In the year 1880, however, on entering his sophomore year, he changed his work to that of natural history. He became a junior in the collegiate department in the regular course of events in September, 1881, still enrolled in his newly chosen field of natural history.

In 1882 Mr. Dyche was made instructor in natural history, but retaining his place in the junior class. He continued his connection with the instructional side of the university until his death. Mr. Dyche was graduated from the university in June, 1884, receiving two degrees, that of Bachelor of Arts and that of Bachelor of Sciences, he having combined both the classical and scientific work then offered in the university. He continued his study in natural history at the university of Kansas by entering the postgraduate course in September, 1884, receiving his Master of Arts degree in 1886 and his Master of Science degree in 1888. His teaching title was during these years "assistant," being equivalent to the title of assistant professor at the present time.

In September, 1888, he was advanced from the rank of assistant in natural history to that of full professor of anatomy and physiology, taxidermist and curator of mammals, birds and fishes. In 1890 zoology was added to his list of teaching subjects. We must remember, however, that in the nineties the number of both students and teachers was small and

[64] Geo. B. Adams, *Am. Hist. Rev.*, 14, 236.

the field of work had not been so carefully differentiated as at present. In September, 1892, physiology and anatomy were dropped from his title and he limited himself to the field which he occupied with little change until the end of his career. His title became professor of zoology, taxidermist and curator of mammals and birds. Francis H. Snow was then chancellor of the university.

It stood thus until 1899 when anatomy for a year was again put in his charge and his title of curator was that of curator of zoological collections. In the very next year we find anatomy cared for in a separate department and Professor Dyche returning to his work under the title of professor of systematic zoology and taxidermist. In 1903 the title of taxidermist was dropped as being unnecessary and Professor Dyche was given the title which he retained until his death, namely, that of professor of systematic zoology and curator of mammals, birds and fishes. In 1901 the legislature of the state, largely through the efforts of Professor Dyche, appropriated $75,000 for the erection of a natural history museum for the housing of the natural history collections. The building was finished in 1902, a considerable part of it being given over to the extensive and important collection of North American mammals and birds.

On December 1, 1909, Professor Dyche was given partial leave of absence in order that he might act as fish and game warden for the state of Kansas. This action was taken by the board of regents of the university at the request of the then governor, W. R. Stubbs. This request was acceded to for the reason that of all men in the state of Kansas Professor Dyche was the most competent in every way to carry on a large project of this character on a scientific basis. It was acceded to also with the belief which has been fully substantiated that the fish hatchery under his supervision could be put upon an economic and scientific foundation.

Since December, 1909, Professor Dyche has given most of his time to the fish and game wardenship although still connected with the university as professor of systematic zoology and curator of mammals, birds and fishes. For some years prior to 1909 Professor Dyche had done little or no undergraduate class work, confining himself to work as curator, investigator and writer, and to such occasional graduate work as was desired by students expecting to enter the museum field.

During his long career as a teacher, in connection with other university men, he took part in or conducted many scientific expeditions, twenty-three in all it is said, for the collection of museum material. These expeditions covered practically all of North America. Some of the most important were to Greenland and the Arctic regions. Of the Peary expedition and the rest it is not for me to speak. They were filled with strenuous endeavor and many thrilling experiences. Indeed few men even of bygone border times could equal his experiences in this respect. He was a noted hunter and won his place as an explorer, his talents as naturalist, woodsman, hunter and explorer being of a high order. The result of all of this was no doubt to shorten his days but he helped build up large scientific collections of great value into which he had put his life and he saw them become an integral part of the university which he loved. He was one of the charter members of the chapter of Sigma Xi at the University of Kansas. He lectured much and in this field was exceedingly graphic and interesting. He wrote much, his last writings being in the shape of bulletins in regard to fish culture in the large. These bulletins are much sought after and show the results of a life time of close observation and study. As a taxidermist he had few equals, his knowledge of the pose and habits of animals and the habitat in which they live being unusually accurate. His fidelity to nature, his great skill and his keen observation are well attested by the brilliant display of North American mammals which he was largely instrumental in preparing at the University of Kansas.

Professor Dyche had in larger degree than most men the creative instinct, the instinct

of originality. He had immense persistence and enthusiasm, well attested by his accomplishments against great odds. A mere study of his life is in itself thrilling. He leaves an honored name of which his family may well be proud. He was an extremely likeable man, a loyal son of his university who brought much honor to his alma mater.

FRANK STRONG

UNIVERSITY OF KANSAS

THE BONAPARTE FUND OF THE PARIS ACADEMY OF SCIENCES

THE committee appointed to deal with the allocation of the Bonaparte Fund for the year 1914, has, we learn from *Nature,* made the following proposals, which have been unanimously adopted by the academy:

1. 2,000 francs to Pierre Breteau, to enable him to pursue his researches on the use of palladium in analysis and in organic chemistry.

2. 2,000 francs to M. Chatton, to give him the means of continuing his researches on the parasitic Peridinians.

3. 3,000 francs to Fr. Croze, to enable him to continue his work on the Zeeman phenomenon in band and line spectra, the amount to be applied to the purchase of a large concave grating and a 16-cm. objective.

4. 6,000 francs to Dr. Hemsalech, for the purchase of a resonance transformer and a battery of condensers for use in his spectroscopic researches.

5. 2,000 francs to P. Laïs, director of the Vatican Observatory, to assist in the publication of the photographic map of the sky.

6. 2,000 francs to M. Pellegrin, to facilitate the pursuit of his researches and the continuation of his publications concerning African fishes.

7. 2,000 francs to Dr. Trousset, to aid him in his studies relating to the theory of the minor planets.

8. 2,000 francs to M. Vigouroux, to assist him in continuing his researches on silicon and its different varieties. These researches, in which it is necessary to make use of hydrofluoric acid, necessitate the use of expensive receivers.

9. 3,000 francs to M. Alluaud, for continuing the publication, undertaken with Dr. R. Jeannel, of the scientific results of three expeditions in eastern and central Africa.

10. 9,000 francs to be divided equally between MM. Pitard, de Gironcourt, and Lecointre, all members of the scientific expedition to Morocco organized by the Société de Géographie.

11. 2,000 francs to Professor Vasseur, to assist him in his geological excavations in a fossil-bearing stratum at Lot-et-Garonne.

12. 3,500 francs to Dr. Mauguin, for the continuation of his researches on liquid crystals and the remarkable orientation phenomena presented by these singular bodies when placed in a magnetic field. The grant will be applied to the construction of a powerful electromagnet.

13. 2,000 francs to Dr. Anthony to meet the cost of his researches on the determinism of the morphological characters and the action of primary factors on the course of evolution.

14. 4,000 francs to Professor Andoyer, a first instalment towards the cost of the calculation of a new table of fifteen figure logarithms.

15. 4,000 francs to M. Bénard, to enable him to continue his researches in experimental hydrodynamics on a large scale.

16. 2,000 francs to Dr. Chauvenet, to enable him to continue his researches on zirconium and its complex combinations.

17. 2,000 francs to Professor François Franck, for the chronographic study of the development of the embryo, with special examination of the rhythmic function of the heart.

18. 2,000 francs to Professor Sauvageau, for the pursuit of his studies on the marine algæ.

SCIENTIFIC NOTES AND NEWS

THE gold medal of the Royal Astronomical Society has been conferred on Professor A. Fowler for his work in astrophysics.

THE Berlin Anthropological Society has awarded its Rudolf Virchow Medal to Dr. Karl Poldt, emeritus professor of anatomy in Vienna.

PROFESSOR FRITZ HABER and Professor R. Willstätter, both of the Kaiser Wilhelm Institute for Chemistry, have been elected members of the Berlin Academy of Sciences.

DR. HANS MEYER, known for his explorations in Africa, has been elected honorary professor of colonial geography in the University of Leipzig.

DR. PIERRE WEISS, professor of physics in the Zurich Technical School, has been awarded

the Lasferre prize ($1,600) by the French Institute.

DR. JOSEF ENGLISCH, emeritus professor of surgery in the University of Vienna, has celebrated his eightieth birthday.

DR. ALFRED KLEINER, professor of physics at Zurich, has on account of the state of his health retired from his chair and has been made honorary professor.

MR. T. F. BURTON has succeeded Mr. Watson Smith as editor of the Journal of the Society of Chemical Industry, which is issued fortnightly in London by the society.

PROFESSOR G. C. BOURNE, Linacre professor of comparative anatomy at Oxford, has been given leave of absence to engaged in military service.

WE learn from *Nature* that the second Indian Science Congress, organized by the Asiatic Society of Bengal, was held at the Presidency College, Madras, on January 14–16, under the presidency of Surgeon-general W. B. Bannerman. The sections of the congress, and their chairman, were as follows: Agriculture and applied science, Dr. H. H. Mann; physics, Mr. C. V. Raman; chemistry, Professor P. C. Ray; zoology, Dr. N. Annandale; botany, Dr. C. A. Barber; ethnology, Mr. H. V. Nanjundayya; geology, Dr. W. F. Smeeth.

PROFESSOR R. W. THATCHER, chief of the division of agricultural chemistry of the University of Minnesota, has been elected president of the Minnesota Section of the American Chemical Society. The section will hereafter hold regular meetings on the third Friday evening of each month at various laboratories in the Twin Cities.

DR. A. F. GILMAN, head of the chemistry department of Ripon College, has returned for the second semester's work after a leave of absence for a half year spent in study and travel.

PROFESSOR JOHN DEWEY delivered the eighth series of McNair lectures at the University of North Carolina on February 5, 6 and 7. His subject was "Philosophy and Politics." The lectures dealt with (1) The Inner and Outer Worlds, (2) The State and Moral Life, (3) The German Philosophy of History.

DR. C. WARDELL STILES, of the U. S. Public Health Service, gave the ninth Weir Mitchell lecture of the College of Physicians, Philadelphia, on February 16. His topic was: "An Experiment from the Standpoint of Applied Zoology in Medical Inspection of Schoolchildren as a Basis for an Intensive Public Health Campaign."

DR. LILIAN WELSH, professor of physiology and hygiene at Goucher College, Baltimore, spoke on February 12 at Mt. Holyoke College on "American Women in Science." The lecture was given under the auspices of the Nettie Maria Stevens memorial lectureship fund, established by the Naples Table Association, for promoting laboratory research for women. The lecture was also given during the week at Wellesley College and Brown University.

PROFESSOR DOUGLAS W. JOHNSON, of Columbia University, lectured before the Engineers Club of Trenton, N. J., on February 11, on "The Topography of Western Europe and its Influence on the Campaign against France." On January 15 he delivered the same lecture before the Geographical Society of Philadelphia.

PROFESSOR ARTHUR H. BLANCHARD, of Columbia University, on February 9, delivered an illustrated address on the subject "Economic Phases of Highway Engineering" before the Middletown Scientific Association at its meeting at Wesleyan University. On February 11 he delivered an address on "The Highway Engineer in Public Life" at the annual meeting of the Engineers Society of Northwestern Pennsylvania.

THE Illinois State Museum of Natural History announces a course of four popular illustrated lectures on natural history on Friday evenings as follows:

February 19—"Volcanic Emanations," by A. L. Day, Ph.D., director Geophysical Laboratory, Washington, D. C.

February 26—"The Wonderful Heavens," by F. R. Moulton, Ph.D., professor of astronomy, University of Chicago, Chicago.

March 5—"The Trophies of the Fossil Hunter," by A. R. Crook, Ph.D., curator Illinois State Museum, Springfield.

March 12—"Alaska Salmon," by H. B. Ward, Ph.D., professor of zoology, University of Illinois, Urbana.

The University of Oxford has received $2,200, as we learn from *Nature*, from friends of the late Professor Gotch, with the view of perpetuating the memory of the late Waynflete professor, and of encouraging the study of physiology within the university. The income of the fund will be applied, first, to the establishment of a Gotch memorial prize to be awarded annually, after examination, to a student in the physiological laboratory; and, secondly, to the creation and maintenance of a Gotch memorial library in the same laboratory. A portrait of Professor Gotch has been hung on the walls of the department.

Samuel Walker Shattuck, for forty-four years professor and comptroller of the University of Illinois, died at his home in Champaign on February 13. Professor Shattuck was born in 1841, at Groton, Mass. Since 1868 he has served the University of Illinois. For thirty-seven years he was head of the department of mathematics and from 1873 to 1912 he looked after the business affairs of the university. In 1912 Professor Shattuck was retired on the Carnegie Foundation.

Mr. F. W. Rudler, curator of the Museum of Practical Geology, London, died on January 23.

Dr. Karl Ludwig Moll, formerly professor of mechanical engineering in the Riga School of Technology, has died at the age of eighty-three years.

Dr. Nicolas Oumoff, professor of physics at Moscow, has died at the age of sixty-eight years.

There have been killed in the war, M. Robert Douvillé, paleontologist in the Paris School of Mines; Dr. Anton Lackner, docent for geometry in the Vienna Technological Institute; Dr. Rudolf Rau, formerly professor of physics at Jena, and Dr. Felix Hahn, geologist of the University of Munich.

The Berlin correspondent of the *Journal* of the American Medical Association writes that according to the latest official list, 132 medical men have so far been killed in the war, 22 wounded, 45 have died and 166 are missing or prisoners. Among the medical victims of the war are three distinguished scientific men, Professor Jochmann, the medical head of the infectious department of the municipal Rudolph Virchow Hospital, succumbed to typhus fever which he acquired in the examination and treatment of Russian prisoners of whom 800 are ill with typhus. Professor Sprengel, the superintendent of the surgical department of the Ducal Hospital in Brunswick, died from sepsis at the age of sixty-two, having infected himself at an operation on a wounded soldier. The Freiburg dermatologist, Professor Jakobi, died in the field as a result of disease.

The U. S. Civil Service Commission announces an examination for assistant in agricultural geography, for men only, to fill a vacancy in this position in the Office of Farm Management, Bureau of Plant Industry, Department of Agriculture, Washington, D. C., at a salary ranging from $1,800 to $2,000 a year. The duties of this position will be to assist in investigations being carried on in the above office concerning the development of agricultural enterprises under the influence of geographic conditions, such as topography, climate, soil, location, etc.

The Robert D. Brigham Hospital for Incurables benefits to the extent of $50,000 by the will of Mrs. Ellen A. R. Goldthwait, of Boston. This sum is to constitute a fund to be known as the Joel and Ellen Goldthwait Research Fund, and the income is to be used for work to increase the knowledge of chronic diseases.

It is stated in *Nature* that a meeting of the General Organizing Committee for the International Botanical Congress, which has been arranged to be held in London next May, took place at the Linnean Society's rooms on January 21. A report was given of the work of preparation which had already been carried out by the executive committee, and the mem-

bers were asked to consider the present position. The two following resolutions were carried: (1) That the congress be not held in 1915; (2) that the present executive committee continue to act so long as necessary. The committee was strongly of opinion that a meeting of the congress in London should not be abandoned, and the suggestion was made that it might take place at the next quinquennium, in 1920. But it was agreed that nothing definite could be settled at the present time, and the following resolution was passed: "That the executive committee be authorized to convoke a meeting of the general committee at some future date to consider the date of the congress." It was also decided that in the meantime the general committee be called together once a year.

THE year 1914 was an eventful one in the industry of mining radium, uranium and vanadium ores and had by far the largest year's production yet made. Figures collected by Frank L. Hess, of the United States Geological Survey, indicate that the output amounted to about 4,300 short tons of dry ore carrying 87 tons of uranium oxide and 22.4 grams of metallic radium. The ore was valued at about $445,000. The ore produced in 1913 contained 41 tons of uranium oxide and 10.5 grams of radium, and that produced in 1912 contained 26 tons of uranium oxide and 6.7 grams of radium. About nine tenths of the contained radium is thought to be recoverable under improved processes. Although carnotite, a mineral of these rare metals, contains three times as much uranium oxide as vanadium oxide, the Colorado and Utah ores of these metals generally contain other vanadium minerals in such quantity that vanadium oxide is present in excess of the uranium oxide. However, little is paid for the vanadium, as its separation from uranium is troublesome, and only a few thousand dollars was received in 1914 by brokers or producers for the vanadium in the ores sold. Sandstone impregnated with roscoelite, a vanadium-bearing mica, is mined at Vanadium, San Miguel County, Colo., on the eastern edge of the carnotite field, by the Primos Chemical Co. The total quantity of vanadium in the carnotite and other ores mined during the year was apparently about 432 tons. About the beginning of 1914, owing to the very high prices charged for radium salts, their scarcity, their evident usefulness in treating diseases, the practical impossibility of the poor receiving treatment by radium because of its scarcity and high cost, and to the fact that much of the radium-bearing ore was being shipped out of the country, Secretary of the Interior Lane caused to be introduced in Congress bills reserving radium-bearing lands from entry as mining claims, and providing for government purchase. The bills are still pending. During the year the National Radium Institute conducted, under the supervision of the Bureau of Mines, mining operations at Long Park, near Paradox Valley, in Montrose County, Colo., and a plant at Denver for the production of radium and investigation of processes. The work has been so encouraging that Director Holmes has announced the probable production of radium at one third its present cost. Messrs. Lind and Whittemore, of the Bureau of Mines, state that their investigations show that carnotite carries proportionally to its content of uranium as much radium as pitchblende or other uranium minerals—that is, the radium has reached its maximum ratio to the uranium from which it is derived and is thus in equilibrium. From published results of experiments made on casual specimens of carnotite it had been popularly supposed that carnotite was less rich than pitchblende in radium.

AN unusual feature of the work of the United States Coast and Geodetic Survey, Department of Commerce, during the past summer was the successful use of a one and one half ton automobile truck in transporting an astronomical party and outfit through a portion of the southwest which is generally dreaded by the transcontinental tourist. The party was in charge of Mr. C. V. Hodgson and was in the field from May to October. The trip is the more remarkable when the fact is taken into consideration that the requirements of the work prevented a close adherence to the routes usually followed. Observations were

frequently made on mountain peaks, so the journey was from mountain to mountain, rather than along main traveled roads from city to city. The general route followed by Mr. Hodgson and his party was from Denver, Colorado, to Pecos, Texas, then southwest almost to El Paso, where a detour was made over poor trails through southern New Mexico into Arizona. The central and southern portions of the latter state were rather well covered, the itinerary including Solomonsville, Douglas, Benson, Tucson, Globe, Phoenix, Yuma and Parker. The auto truck was then driven across California to San Diego and the San Jacinto mountains, thence via Los Angeles, Mojave and Sacramento to Carson City, Nevada. Astronomical observations were carried along the California-Nevada boundary to Needles, California, where the season ended. During the season the truck, carrying a capacity load, was run more than 5,000 miles under road conditions varying from the deep mud encountered in New Mexico and Texas, and the heavy sands of the Colorado River and Nevada desert regions, to the splendid roads of southern and central California. The cost sheets of the season show that the work was done at a saving of at least 35 per cent. from the cost had teams been used. The cost per mile for oil and gas varied from 2.7 cents to 6.6 cents in different sections of the country, and averaged 3.9 cents for the entire season. A remarkable feature of the performance of the truck and a tribute to the good work of the driver was the fact that, from the time of leaving Colorado Springs to the end of the season, about six months, during which the truck was run over 5,000 miles, only two hours were lost on the road on account of engine troubles.

We learn from the *Geographical Journal* that Messrs. Geo. Philip and Son, Ltd., have prepared a relief model map of Central Europe, constructed to illustrate the topography of the main theaters of the present war. The model, which costs £6, 6s., measures 62 by 35 inches, and is on a horizontal scale of 18 miles to the inch, and a vertical one of 5,000 feet to the inch, so that the heights are exaggerated nineteen times. Political boundaries are shown, and also towns in red, but neither roads nor railways. The model is said to show well the continuity of the Central Plain from Russia westwards to the margin of the North Sea and the Channel, and thus makes clear at once the exposed frontier of Germany, and the military reason for the violation of Belgian neutrality. Most of the places which have become famous in the western war area are marked, and it is possible to follow very clearly the battle lines of the Marne and of the Aisne, the fighting in the Argonne region, the conflicts round Ypres and the Yser, and so on. Among minor features which are well shown, are the position of the gap of Toul, due to the fact that a stream which once ran into the Meuse has been captured by the Moselle, and the deserted valley forms an open groove between the two rivers, a groove through which passes the railway from Paris to Toul and Nancy. The position of Reims, also, placed as it is on a natural line of communication between Champagne, Burgundy, the middle Rhine valley and the Low Countries, is clearly seen, and it helps to explain the constant bombardment of that ill-fated city, whose splendid cathedral illustrates its early importance as a crossing-point of routes.

We learn from the *Journal* of the American Medical Association that the secretary of state of Missouri has issued articles of incorporation to "The Missouri Foundation for Health Conservation," the purposes of which are "the conservation of health and the prevention of disease to the end that human efficiency may be increased and human suffering prevented." Its purposes are to be secured by any means "that demands of time or of science may require." The first activity undertaken will be a medical laboratory to be established at St. Joseph, with its tributary population of $1,000,000. It is intended that this institution shall be a clearing-house where all doctors living in the country tributary to St. Joseph may send specimens from patients for analysis and get prompt returns. The work will be financed by fees, donations, subscriptions and bequests, its aims being

scientific, social and benevolent and not commercial. In addition to the medical laboratory, other activities for health conservation will be inaugurated. The secretary of the foundation is Dr. Daniel Morton, St. Joseph, and the members of the board of control are prominent citizens of St. Joseph and the state.

From the annual statement of the British board of trade *Nature* prints figures for 1913 of imports of scientific instruments and apparatus, as follows:

Scientific Instruments and Apparatus (other than Electrical) Complete

		£
Total imports		710,341
Of which from	Germany	362,891
	Belgium	28,939
	France	108,040
	Switzerland	19,872
	U. S. A.	182,293

Parts thereof (including Kinematograph Films, Photographic Plates and Films, and Sensitized Photographic Paper)

		£
Total imports		2,373,426
Of which from	Germany	310,229
	Belgium	126,725
	France	522,682
	Switzerland	28,762
	Italy	121,842
	U. S. A.	1,256,311

It thus appears that the imports from the United States exceed those from France and Germany combined. It may be expected that hereafter the imports of scientific apparatus (of which, however, photographic supplies are a considerable part) from the United States will exceed those from all other countries combined.

UNIVERSITY AND EDUCATIONAL NEWS

The Thomas W. Evans Museum and Dental Institute, School of Dentistry, the University of Pennsylvania, will be dedicated on February 22 and 23. On the afternoon of February 22 the presentation and formal opening of the building will take place and addresses will be made as follows:

Dr. Charles Gordon, of Paris, France.

Dr. Wilhelm Dieck, of Berlin, Germany.

Mr. John Howard Mummey, M.R.C.S., L.D.S., of London, England.

Dr. William Simon, of the Baltimore College of Dental Surgery

Dr. Edward C. Kirk, dean of the Thomas W. Evans Museum and Dental Institute School of Dentistry, University of Pennsylvania.

The new building of the Mellon Institute of Industrial Research of the University of Pittsburgh, will be dedicated on the morning of February 26. The principal address will be made by Dr. Rossiter W. Raymond. In the evening Professor John J. Abel, of Johns Hopkins University, will deliver the first Mellon Lecture under the auspices of the Society for Biological Research of the University of Pittsburgh. The subject of the lecture will be "Experimental and Chemical Studies of the Blood and Their Bearing on Medicine."

Dr. Karl T. Compton, instructor in physics at Reed College, Portland, Oregon, will go to Princeton University next fall as assistant professor of physics. Dr. Compton received the degree of Ph.D. at Princeton in 1912.

Two new members have been recently added to the faculty of the New York State College of Forestry. Mr. G. A. Gutches, formerly in the U. S. National Forest Service, later district forest inspector of Saskatchewan, Canada, becomes director of the New York State Ranger School at Wanakena, N. Y. Mr. H. H. Tryon, formerly forest engineer, becomes instructor in forest utilization. This makes eight new appointments to the faculty of the New York State College of Forestry within the past year. The appointment of Dr. C. C. Adams as assistant professor of forest zoology was noted in Science of June, 1914. The other recent appointments are as follows: Dr. J. Fred Baker, formerly professor of forestry in Michigan Agricultural College, as professor of experimental forestry; Dr. L. H. Pennington, formerly associate professor of botany in Syracuse University, as professor of forest pathology; Dr. H. P. Brown, formerly instructor at Cornell, as assistant professor in forest botany; Mr. Shirley W. Allen, formerly deputy forest supervisor of the Lassen National Forest, California, as assistant professor of

forest extension, and Mr. L. D. Cox, formerly landscape architect to the Park Commission of Los Angeles, as assistant professor of landscape engineering.

Sir Henry Miers, formerly professor of mineralogy at Oxford, has resigned the principalship of the University of London to become vice-chancellor of Manchester University.

Mr. L. G. Owen has been appointed professor of mathematics at the Government College, Rangoon.

Dr. Rudolf Höber has been made professor of physiology at Kiel, in succession to Professor A. Bethe, who has accepted a call to Frankfurt.

DISCUSSION AND CORRESPONDENCE

A TYPICAL CASE

Professor —— graduated at —— University and, taking a post-graduate course, received the degree of Ph.D. He then went abroad, studied at the —— University, and returned to America, full of enthusiasm for original research. He had published an important memoir for a thesis, which was well received, his instructors encouraged him and his fellow students appreciated and were interested in his work.

He now received an offer of a professorship in a small country college, married, and began his new life expecting to continue his investigations. He soon found that his entire time was occupied in teaching, and that he was obliged to eke out his small salary by writing and lecturing. He could not bear to abandon his great object, the advancement of human knowledge, and found that he could, by extra efforts, devote a portion of his evenings to research, amounting to a fourth of his entire working capacity. He went to the president of the college, asking for an appropriation for an assistant, who could do the routine work of copying, computing, etc., as well and as rapidly as he could himself. Instead of a quarter of his time, he would thus have one and a quarter, or five times as much, and could make rapid progress at small expense. The president told him that the object of the institution was teaching, not research, and that it was impossible to grant his request. A fellowship was, however, vacant, and might answer his purpose. This, however, would be of no use to him, as the fellow would not want to do routine work, but to undertake a research of his own, and would expect to be taught how to do it. His associates were teachers, not investigators, and took no interest in his plans. After repeated trials and discouragements, he abandoned his efforts and settled down as a teacher only, with no ambitions beyond enabling his classes to pass their examinations.

While good teachers are as much needed as investigators, the work of the latter may be greatly impeded if their main energy is devoted to instruction. The finding of such men, and enabling them to carry on the great work, for which they are fitted, by providing them with apparatus, assistants, or means for publication, is one of the principal objects of the Committee of One Hundred on Scientific Research.

Edward C. Pickering

January 27, 1915

A SPHENOIDAL SINUS IN THE DINOSAURS

The work which has been done recently on the accessory nasal sinuses in man and the mammals by H. W. Loeb, J. P. Schaeffer, Onodi, Ernst Witt, Ritter, A. W. Meyer, as well as the earlier work of Zuckerkandl, may receive some interesting additions from paleontology. While in no sense intending to affirm any genetic relations between the dinosaurs and mammals it is yet an interesting fact that a large sinus occurs in the sphenoidal region of dinosaurs and labyrinthodonts. It has previously been largely confused with the pituitary fossa near which it lies but recent work tends to show a distinction between this fossa for the lodgment of the hypophysis and the *recessus basisphenoidalis* as it is called by Osborn[1] who has figured this cavity very clearly in *Tyrannosaurus rex*, the huge carnivorous dinosaur from the Cretaceous. The

[1] Osborn, H. F., 1912, *Mem. Amer. Mus. Nat. Hist.*, N. S., Vol. 1, Pt. 1, Pls. III. and IV.

cavity in this dinosaur is quite extensive and corresponds in position to the human sphenoidal sinus and resembles this structure in some of its complications such as are occasionally found in man. The structure seems to occupy portions of both the basisphenoid and the basioccipital and to extend a considerable distance toward the occipital condyle. There are five, possibly six, saccular divisions of the sphenoidal sinus (recessus basisphenoidalis). These divisions recall the saccular divisions of the sphenoidal and frontal sinuses of man and from their smooth walls one would expect to find a membranous lining as in man. So far as I am aware this cavity has no connection with the nasal cavity, although such a connection may be demonstrated from additional or from a restudy of present material. The recess lies below and between the points of exit of the third and twelfth cranial nerves, the mass of the brain being immediately above it. Several authors have observed a similar depression in the sphenoidal region of the Labyrinthodont skull and in other primitive vertebrates, notably the early reptiles. It is a well known fact that the hypophysis and particularly the posterior portion of this structure is, in the early land vertebrates, quite large and it has been the natural assumption that the large recess near where the hypophysis occurs should lodge the glandular organ, but it is entirely probable that the recess is the sphenoidal sinus. There is no necessity of adopting Osborn's term *recessus basisphenoidalis* since there is no doubt that the structure corresponds well with the *sinus sphenoidalis* of man. It is to be hoped that someone will take up the question of the general homologies of these cavities in different groups of vertebrates so that we may have a firm basis on which to work. The value of fossil animals in furnishing facts of anatomical importance has never been fully realized and it is to be hoped that an attempt will be made to fill this gap.

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SCIENTIFIC BOOKS

Human Physiology. By PROFESSOR LUIGI LUCIANI. In four volumes; Volume II. Translated from the Italian by FRANCES A. WELBY. London, 1913.

The realm of physiology has become so extensive that the preparation of an encyclopedic treatise on the subject by a single author is a notable intellectual feat. The admirable manner in which Luciani has accomplished this feat in his *Fisiologia dell' Uomo,* is testified to by translations which have been made into both Spanish and German. Not only does the book include a review of recent and generally accepted observations and interpretations, but also in many subjects an account of the historical development of our knowledge from ancient to modern times. The reader is thus given a perspective which is rarely obtained except by particular historical research.

A very considerable part of the value of Luciani's great handbook arises from his generous citation of original sources, both old and recent. This feature gives the exposition a permanent utility for the careful student who desires to become acquainted with reports by the discoverers themselves. Such a student should not depend wholly on English and German references to literature; he would do well to examine also French and Italian summaries, for, it must be admitted, there are not infrequently possibilities of tracing work thus which has not been represented where we have been most accustomed to look. Luciani's bibliographies present a rich mine of references to Italian as well as to other original papers.

The present volume (number II. of the four volumes of an English translation) is a good example of the whole. It is concerned with the internal secretions, the digestive secretions, the processes of digestion both mechanical and chemical, absorption and excretion. Many of the illustrations are taken from the original investigations, and a number of them are colored. The chief criticism that can be made against the work is that during the time required for its writing and being translated physiology has been going

forward so rapidly that important researches of the past four or five years are not found included in it. This defect, however, as intimated above, may be regarded as compensated for by the comprehensive and historical sweep which characterizes Luciani's survey of the subject. W. B. Cannon

The Wonder of Life. By J. Arthur Thomson. New York, Henry Holt and Company. 1914.

Once more we are indebted to Professor Thomson for a semipopular work on biology, this time with contents of a very miscellaneous character, better to reflect the varied aspects of living nature. We have, in fact, a biological (mainly zoological) scrap-book, full of interesting matters gleaned from more or less recent literature, carefully selected and digested for our benefit. All this is loosely thrown together under several general headings, "The Drama of Life," "The Haunts of Life," "The Insurgence of Life," "The Ways of Life," "The Web of Life," "The Cycle of Life" and "The Wonder of Life," with more than 300 separate minor topics. Each chapter is headed by a selection from the aphorisms of Goethe, as translated by Huxley. The book is admirably adapted for "supplementary reading" in a course on biology or zoology, or it might itself be made the basis of a seminar course. Its great value lies in its wide scope and breadth of view, with every emphasis on vital phenomena rather than on morphological details or classification. It is addressed, however, to an educated public, and even in places presupposes more zoological knowledge than most of us can boast. For example, on page 105 we are pulled up short by the startling announcement that "no one expects to find a Crustacean like *Byotrephes longimanus* in a pond." It is probably true that very few have ever approached a pond with any such expectation! Doubtless it is good for us, however, to bump now and again into things we do not understand, merely to diminish that conceit which too readily develops after reading discussions so lucid as those of Professor Thomson.

The specialist will here and there find things not quite up to date, or stated without sufficient reference to diverse points of view, but the general impression gained is that the work is admirably done, and that in all probability no other naturalist could have done it better, if so well. The illustrations, including many colored plates, are pleasing and instructive, but not up to the standard of the text. Some are really bad, as Fig. 81, a colored plate of leaf-insects (*Phyllium*). The coloring of the foliage, to correspond with the insects, is unnatural and without any adequate basis; while the insects are drawn from mounted specimens with the legs spread in the conventional way, without any reference to the plant on which they are supposed to be resting! The most ridiculous object is the young one, shown as resting on a nearly upright branch, with its legs waving wildly in the air. The whole thing is certainly, as it stands, a piece of "nature-faking." Fig. 39, representing young spiders, shows some of them with the head and thorax separate, like an insect.

There is a passage on page 595, beginning the discussion of the Transmissibility of Acquired Characters, which indicates that such transmission is perfectly easy in unicellular animals, which simply divide into two. Jennings has well shown the fallacy of this naïve conception, and it seems surprising that Professor Thomson should offer it, not merely as an idea, but as a well-known fact.

T. D. A. Cockerell
University of Colorado

SPECIAL ARTICLES

MICRODISSECTION STUDIES ON THE GERM CELL[1]

This paper records a continuation of the observations published recently[2] in Science on the male germ cells of the grasshopper, *Disosteira Carolina,* and of the cockroach, *Periplaneta Americana.* The cells were iso-

[1] Slightly modified from a paper read before the American Society of Zoologists, Philadelphia, December 29, 1914.

[2] Robert Chambers, Jr., "Some Physical Properties of the Cell Nucleus," Science, N. S., XL., p. 824, 1914.

lated and studied by means of microdissection and vital staining in a hanging drop of the insect body fluid in Barber's moist chamber.

The cytoplasm exhibits an extreme variability in its consistency. On tearing it may go into solution, setting free the nucleus and the cytoplasmic granules. Often the cytoplasm goes into solution with a rapidity suggestive of an explosion. A slight tearing of the surface is followed by a moment of apparent inactivity. Then comes a slight convulsive movement and the torn surface opens up, a swelling appearing especially at this place. Within a few seconds nothing remains but the nucleus and the mitochondria in the form of granules or a network. The nucleus in its turn swells and goes into solution. The mitochondria persist for a much longer time. Individuals are also met with whose cells retain their shape, the torn region being gradually obliterated by a closing in of the surrounding cytoplasm.

It is significant that all the cells of a given individual are constantly uniform in their behavior.

In an attempt to ascertain the cause for this variability in the consistency of the protoplasm a series of experiments has been planned, one of which is the investigation of the germ cells of food and water starved individuals. Cockroaches starved for three weeks in a dry heated room were found uniformly to possess germ cells remarkable for their toughness and resistance to mechanical injury.

"Physiological" salt solutions in various dilutions were all found to produce a swelling effect on the cell. The first evidence of this in isolated cells is the assumption of a spherical shape. The addition of a trace of egg albumin counteracts the swelling to a slight extent. As swelling proceeds the viscosity of the protoplasm at first increases, agglutination phenomena becoming very marked. Later the viscosity is lost, possibly due to the increased imbibition of water.

When observed in body fluid, the cells tend to keep their irregular shapes. Spermatocytes exhibit slow amœboid movements. Isolated cells, however, soon become spherical. They also become spherical and swell on injury as when they are punctured with a needle.

The mitochondria in the primary spermatocyte of *Disosteira* form a voluminous granular network surrounding the nucleus, plainly visible in the fresh unstained cell. The delicate tracery of the mitochondrial structures in this, and in subsequent, stages is shown beautifully with Janus green, beside which similar structures seen in fixed material appear crude and in many respects erroneous. If the Janus green stain be heavy, its coagulative effect is apparent in the increase and clumping together of the granules. If the cell be torn, the cytoplasm goes into solution and the stain very soon fades out, the granules swell and coalesce, forming irregular lumpy masses which persist for a long time.

During metaphase the mitochondrial network is pulled out into a spindle-shaped structure investing the viscous kinoplasmic material. Tearing of the cytoplasm causes a loss in the bipolar arrangement of the cell structures, the mitochondrial strands wrinkle and the whole spindle becomes distorted. The chromosomes scatter. Within a few minutes the relatively dense kinoplasmic mass goes into solution leaving the mitochondrial network with the chromosomes irregularly dispersed inside. In one such case two spermatozoa corkscrewed their way between the meshes of the mitochondrial spindle. Whenever their tails touched the viscous material of the meshes violent lashings were necessary to set themselves free. One struck its head against a mesh and was held prisoner for several minutes until the viscosity of the material was decreased during the dissolution process. The other spermatozoon hit a chromosome which stuck to its tail and the spermatozoon twirled away dragging off the chromosome.

During anaphase and telophase the granules and strands of the mitochondrial network are lengthened into delicate filamentous threads lying between the two groups of chromosomes. These are the interzonal filaments or the spindle-rest described in fixed material. As constriction between the daughter cells progresses, the tension of the fila-

ments diminishes. Their tips vacuolize and appear lumpy, giving evidence again of a network arrangement of granules. As the constriction deepens, the cluster assumes the form of an hour-glass. The Janus green stain now disappears at the middle as if the mitochondrial material were drawn away or had gone into solution. In late telophase the substance of one daughter cell may be torn away from the other cell leaving the mitochondrial filaments projecting in naked strands which soon wrinkle and curl and finally coalesce into a lumpy mass.

Cells in late anaphase and telophase may be caused to assume a spherical shape by mechanical agitation or tearing with the needle. The mitochondrial spindle is then very much distorted, the filaments become wrinkled and tangled. At the end of the cell division, each daughter cell contains a cluster of mitochondrial filaments which have already begun to be transformed into a granular network mass which gradually spreads around the nucleus. The mitochondria are not stable structures. Granules at one moment may draw out into threads, or coalesce with their neighbors, or go into solution, freshly formed granules replacing them.

In the spermatid the mitochondria mass at one side of the nucleus to form the Nebenkern. The mitochondrial granules, at first loosely distributed, soon collect into a compact body which stains a solid blue with Janus green. On dissecting the Nebenkern out of the cell, it disintegrates into granules which persist as such for some time.

The development of the axial filament was closely followed in the cockroach. It originates in connection with an apparent sloughing off of material from the surface of the Nebenkern. The coiled filament thus formed is bordered on two sides with a longitudinal row of granules collected at very regular intervals in small uniform clumps. The filament itself does not stain with Janus green, the bordering granules, however, become intensely blue. One may watch the filament gradually uncoil and loosen from the Nebenkern. One end is inserted in a conical knob, (the blepharoblast), on the surface of the cell nucleus. As it uncoils, it forms a loop curving along the periphery of the cell. The uncoiling is accompanied by an oscillatory movement which begins at the knob and passes in a wave along the filament. This movement gains in strength until the whole body of the cell is thrown into ever recurring waves. The movement is instantly arrested when the cytoplasm is torn by the needle. The cytoplasm then goes into solution and the filament either straightens out or deepens its curve possibly according to the character of the wave at the moment the spermatid is torn. The filament remains attached to the nucleus and may be dragged about with a needle. It is elastic and rigid and keeps its shape perfectly for the short time before it goes into solution. During the process of its elongation the spermatid is very susceptible to touch. A slight prick with the needle will cause it to assume a spherical shape. This is accompanied by a distortion of the double row of granules alongside the axial filament so that one may observe the wave pass along one row slightly ahead of that along the other.

When examined in Ringer's fluid or when the spermatid is disturbed by the needle, the clumps tend to round off in the form of vesicles. This is especially noticeable in the case of the two largest clumps close to the nucleus. Such an appearance is commonly met with in fixed material. As the filament straightens, the cell is drawn out into an attenuated body. The granules along the filament coalesce to form two narrow uniformly homogeneous bands which extend alongside the spherical nucleus to the anterior tip of the spermatid. The nucleus condenses into an optically homogeneous and highly refractive body which gradually lengthens into the rod shape of the mature spermatozoon. A large double clump of granules which lies immediately behind the nucleus condenses and forms the neck piece. The throwing off of clumps of cytoplasm was never observed except in preparations in salt solutions or in old body-fluid preparations where such cytolytic action was apparent in all the cells present.

The perforatorium of the ripe spermatozoon tapers off in the form of a corkscrew. In Ringer's fluid it swells into a bleb-like process and as such is figured by Duesberg and Morse. The tail has two movements, a whip-like lash and a twirl, its base being used as a pivot. These two movements whirl the spermatozoon forward in a corkscrew fashion. It may be noted that the lashing movement of the spermatozoon tail is directly comparable to the waving of the axial filament within the spermatid.

In conclusion I wish to emphasize the following points drawn from this and from my previous paper:

1. As far as nuclear structures are concerned the study of fresh material corroborates, in many interesting details, the observations made in fixed material. Both methods are necessary for a proper understanding of the structures. Our present fixing methods, however, are useless for the study of cytoplasmic and mitochondrial structures and should be replaced by the study of fresh material.

2. "Physiological" salt solutions are more or less injurious to the cells studied which are normally bathed by organic fluids, *i. e.*, liquid colloids.

3. Puncture of a cell by a needle causes irreparable injury. When the injury is slight it at first hastens the normal reversible changes in the physical states of the colloids in the cell but soon transforms them to an abnormal condition from which the cell does not recover.

4. Injury to the cell is always followed by swelling accompanied by an increased inhibition of water.

5. A tension exists in the cell during division which is immediately lost when any part of the cell is torn.

6. Amœboid activities are prevalent among the germ cells. In this way extensive movements occur within the cysts of the testis follicle. When set free in a liquid medium, the amœboid processes are very soon retracted and the cells assume a spherical shape.

The movement in waves of the axial filament of the spermatid starts at the conical knob on the nucleus and accompanies the uncoiling of the filament from the surface of the Nebenkern.

7. The staining of the mitochondria by Janus is probably not due to a chemical combination. In time the stain fades out of the cell. If the stained structure be brought into immediate contact with a liquid it is washed out almost immediately.

8. Janus green, if used in sufficient concentration, will stain the nuclear structures. The dye is reduced to the red safranin even in the presence of abundant air. This has been observed in all stages of the germ cells and also in motile spermatozoa. Such cells, however, soon die. Dead cells take up the blue stain readily, the nuclear structures showing beautifully.

9. Janus green, being a basic dye, coagulates albuminous substances. In living cells this coagulating effect is very noticeable. The stain, therefore, can not be used as the sole means for identifying mitochondria.

10. The mitochondria, in the Orthopteran germ cell, are in accord with those studied by the Lewises[3] in the tissue cells of the chick. They can not be classed as persistent structures. They pass from a granular stage into strands; they may coalesce into homogeneous masses; they disappear and reappear and must be merely changes in physical states of the colloids which compose the cytoplasm.

ROBERT CHAMBERS, JR.
UNIVERSITY OF CINCINNATI

SOME NEW CASES OF APOGAMY IN FERNS. PRELIMINARY NOTE

SEVERAL cultures of *Aspidium tsussimense*, *Pellæa adiantoidis* and *Lastrea chrysoloba* were made beginning June 25, 1914. The spores were sown on sphagnum, which was first placed in small stender dishes, saturated with a one-tenth-per-cent. Knop's solution, and then thoroughly sterilized in an oven.

[3] M. R. and W. H. Lewis, "Mitochondria in Tissue Culture," SCIENCE, N. S., XXXIX., p. 330, 1914.

So far as I have been able to observe, nothing unusual occurs in the early stages of development of the prothallia of any of the three species. The prothallia of *Aspidium tsussimense* and of *Lastrea chrysoloba* grow to a large size and are typically heart-shaped. The prothallia of *Pellæa adiantoidis* are much smaller and in some respects resemble those of *Pellæa atropurpurea,* in which species I described apogamy in 1910.[1] Antheridia are produced in large numbers on many of the prothallia of each of the three species here under consideration. The antherozoids are actively motile and appear to be normal in every respect. Archegonia have been observed on some of the prothallia of *Lastrea chrysoloba.*

On the well-developed cushion of the prothallium of *Aspidium tsussimense,* usually at some distance back of the apical notch, a number of papillate projections appear. These projections frequently occur in groups. Sometimes each consists of a single cell, but more frequently of a single row of cells. In this portion of the prothallium, usually after the projections have been formed, a compact mass of cells appears which develops into an embryo. At an early stage in the formation of this apogamous embryo, tracheids are produced. The developing embryo never produces a foot. The primary leaf as a rule is formed in advance of the primary root. The stem appears later than the leaf and the root. Even while the embryo is very young, numerous scales appear on the petiole of its primary leaf. These resemble the scales so characteristic of the mature sporophyte.

The prothallia of *Pellæa adiantoidis* also produce embryos apogamously. The development of the embryos appears to be similar to that described in my previous paper for that of *Pellæa atropurpurea.* In a number of cases in my cultures the embryo has already formed the primary leaf and the primary root.

When the embryo of *Lastrea chrysoloba* is about to form, a small light region appears between the apical notch and the cushion. In this region the embryo is developed. In all of my cultures the apogamously produced embryo has just begun to project above the surface of the prothallium. Embryos developed from a fertilized egg have not been found. When prothallia-bearing archegonia are placed in a drop of water on a slide and examined microscopically, the archegonia can be observed to open, but antherozoids do not appear to be attracted to them.

While the prothallia of these species of ferns were being grown, numerous cultures of other species maintained under the same conditions of nutrition, light, temperature and moisture, contained prothallia bearing antheridia and archegonia, and in some cases embryos were produced upon these prothallia as a result of fertilization.

W. N. Steil
University of Wisconsin

[1] *Bot. Gaz.,* 42, 400–401, 1910.

THE AMERICAN SOCIETY FOR PHARMACOLOGY AND EXPERIMENTAL THERAPEUTICS

The sixth annual meeting of the Pharmacological Society was held in St. Louis at Washington University Medical School on December 27–30, 1914. There were five scientific sessions, three of them being joint meetings with the other members of the Federation of American Societies for Experimental Biology, the Physiological Society, the Biochemical Society and the Society for Experimental Pathology.

The following officers were elected in the Pharmacological Society for the year 1915:

President: Torald Sollmann.

Secretary: John Auer.

Treasurer: Wm. deB. MacNider.

Additional members of the council: Worth Hale and D. E. Jackson.

Membership Committee: S. J. Meltzer (term expires 1917).

Election of New Members: The following candidates were approved by the membership committee, passed by the council and elected by the society: Dr. F. C. Becht, University of Chicago; Dr. W. H. Brown, Rockefeller Institute; Dr. F. L. Gates, Rockefeller Institute.

The attendance was excellent, but the eastern section of the country was not as well represented as could be desired.

The scientific sessions were opened on Monday, December 28, at 9 A.M. by a joint meeting of the

four societies, Dr. Graham Lusk presiding. The following papers were read and discussed:

"Experimental Hyperthyroidism," by W. B. Cannon, C. A. Binger (by invitation) and R. Fitz (by invitation).

"Further Observations on the Etiology of Goiter in Fish" (read by title), by David Marine.

"Studies on Experimental Cretinism," by H. R. Basinger (by invitation) and A. L. Tatum.

"A Research into the Function of the Thyroid" (read by title), by G. W. Crile, F. W. Hitchings (by invitation) and J. B. Austin (by invitation).

"The Effect of Repeated Injections of Pituitrin on Milk Secretion" (read by title), by S. Simpson and R. L. Hill (by invitation).

"The Action of Pituitrin on the Mammary Gland," by W. L. Gaines (by invitation).

"On the Mechanism of Pituitrous Diuresis" (read by title), F. P. Knowlton and A. C. Silverman (by invitation).

"The Several Factors Involved in the Standardization of Pituitary Extracts," by George B. Roth.

The first scientific meeting of the Pharmacological Society took place in the afternoon at 2 P.M., Dr. Sollmann presiding. The following papers were read and discussed:

"The Fatal Dose of Various Substances on Intravenous Injection in the Guinea-pig," by S. Amberg and H. F. Helmholz.

"Experimental and Clinical Research into Alkalescence, Acidity and Anesthesia" (read by title), by G. W. Crile.

"Effects of Chelidonin on Surviving Organs," by P. J. Hanzlik.

"The Effect of Temperature on the Response of Frogs to Ouabain," by T. Sollmann, W. L. Mendenhall (by invitation) and J. L. Stingle (by invitation).

"Artificial Cerebral Circulation after Circulatory Isolation of the Mammalian Brain," by E. D. Brown.

"The Uterine Action of Quinidin, Cinchonin and Cinchonidin," by Worth Hale.

"Some Vasomotor Reactions in the Liver," by C. D. Edmunds.

"Distribution of Solutions in Cardiectomized Frogs with Destroyed or Inactive Lymph Hearts," by T. S. Githens and S. J. Meltzer.

"The Influence of Intra-intestinal Administration of Magnesium Sulphate upon the Production of Hyaline Casts in Dogs," by F. L. Gates (by invitation) and S. J. Meltzer.

The second scientific meeting was held on Tuesday morning at 9 o'clock, Dr. Sollmann in the chair. The following papers were presented and discussed:

"A Study of the Relative Importance of the Vascular Mechanism of the Kidney and of the Epithelial Element of the Kidney in Determining the Efficiency of Various Diuretics" (read by title), by W. deB. MacNider.

"Cross-tolerance of Drugs," by H. B. Myers (by invitation).

"Vascular Reactions in Poisoning from Diphtheria Toxin," by H. B. Myers (by invitation) and G. B. Wallace.

"The Action of Digitalis in Experimental Auricular Fibrillation," by A. D. Hirschfelder.

"The Effects of Drugs upon the Circulation in the Pia Mater and the Retinal Vessels," by A. D. Hirschfelder.

"The Action of Camphor on the Circulation," by Clyde Brooks and J. D. Heard (by invitation).

"The Effect of CO_2 upon the Convulsant Action of Acid Fuchsin in Frogs," by Don R. Joseph.

"The Mechanism of the Toxic Action of the Heavy Metals on the Isolated Heart," by Carl Voegtlin.

"An Analysis of the Action of Digitalin on the Cardiac Inhibitory Center and on the Cardiac Muscles," by C. W. Greene, L. R. Boutwell (by invitation) and J. O. Peeler (by invitation).

"A Comparative Study of the Influence of the Solvent upon the Toxicity of Thymol," by W. H. Schultz.

"The Reaction of Hookworm Larvæ to Certain Chemicals," by W. H. Schultz.

"A Further Observation on the T-wave when Digitalis is Given," by A. E. Cohn.

The next meeting in the afternoon was a joint scientific session of the societies forming the Federation and the following papers were read and discussed, Dr. Sollmann presiding:

"The Influence of Sodium Carbonate on the Glycosuria, Hyperglycæmia and the Respiratory Metabolism of Depancreatized Dogs" (read by title), by J. R. Murlin and B. Kramer (by invitation).

"The Influence of Depancreatization upon the State of Glycæmia after Intravenous Injections of Dextrose in Dogs," by I. S. Kleiner and S. J. Meltzer.

"The Possibility that some of the Hepatic Glycogen May Become Converted into Other Substances than Dextrose," by J. J. R. Macleod.

"Narcotics in Phlorhizin Diabetes," by R. T. Woodyatt.

"*Adrenal Deficiency*," by R. S. Hoskins.

'Hypoglycemia," by H. McGuigan.

"Some Effects of Adrenalin when Injected into the Respiratory Tract," by J. Auer and F. L. Gates (by invitation).

"The Relation of the Adrenals to the Brain" (read by title), by G. W. Crile, F. W. Hitchings (by invitation) and J. B. Austin (by invitation).

"Further Observations of the Origin of Hydrochloric Acid in the Stomach" (read by title), by A. B. Macallum and J. B. Collip (by invitation).

"The Effect of Various Fluids and Cereals on Gastric Secretion" (read by title), by C. C. Fowler (by invitation), M. E. Rehfus (by invitation) and P. B. Hawk.

"The Distribution of Gastrin in the Body," by R. W. Keeton (by invitation) and F. C. Koch.

"The Relation of the Digestion Contractions to the Hunger Contractions of the Stomach (Dog, Man)," by F. F. Rogers and L. L. Hardt (by invitation).

The third joint session was held on Wednesday morning, December 30, Dr. Lusk presiding. The following papers and demonstrations were presented:

"Recuperation: Nitrogen Metabolism of a Man when Ingesting Successively a Non-protein and a Normal Diet after a Seven-day Fast," by F. D. Zeman (by invitation), J. Kohn (by invitation) and P. E. Howe.

"Some Studies in Autolysis," by H. C. Bradley.

"The Diastase of the Blood," by H. McGuigan and C. L. v. Hess (by invitation).

"The Rate of Oxidation of Enzymes and their Corresponding Proenzymes," by W. E. Burge.

"The Harmful Effect of an Exclusive Vegetable Diet," by C. Voegtlin.

"The Effect of Long-continued Feeding of Saponin from the Bark of *Guaiacum officinale*" (read by title), by C. L. Alsberg and C. S. Smith (by invitation).

"Fat Infiltration of the Liver and Kidney Induced by Diet," by E. L. Opie and L. B. Alford (by invitation).

"On the Nature of the Hepatic Fatty Infiltration in Late Pregnancy and Early Lactation," by V. H. Mottram (by invitation).

"The Synthesis of Hippuric Acid in Experimental Tartrate Nephritis in Rabbit," by F. B. Kingsbury (by invitation) and E. T. Bell (by invitation).

Demonstrations

Blood Pressure Method, by C. Brooks and A. B. Luckhardt.

Demonstration of a Point-to-point Method for Analyzing Induction Shocks by means of the String Galvanometer, by J. Erlanger and W. E. Garrey.

A Device for Projecting a Small Spot of Light Suitable for Exploring Photo-sensitive Areas, by B. M. Potter (by invitation).

Demonstration of the Effect of Sodium-iodoxybenzoate on Inflammation caused by Mustard Oil, by S. Amberg and D. McClure (by invitation).

An Arrangement of the Porter Clock to Give Three Time Intervals at the Same Time, by Worth Hale.

A Portable Respiratory Machine Furnishing Continuous, Intermittent and Remittent Streams of Air, by F. L. Gates (by invitation).

The Determination of Blood Sugar, by P. A. Shaffer.

On Wednesday afternoon the local committee arranged a series of enjoyable visits to the St. Louis hospitals and laboratories and also to the beautifully located, impressive buildings of Washington University.

Dinners and Smokers.—This part of the program was inaugurated by a dinner given by the local committee on Sunday evening, December 27, to the officers and councils of the constituent societies of the federation and of the Anatomists.

The customary and universally satisfactory informal subscription dinners and smokers were held on the evenings of December 28, 29 and 30; the first two at the Hotel Jefferson and the last one at the Hotel Warwick. Perhaps the most enjoyable of these was the first on December 28, when a number of excellent speeches were delivered, the speakers being the guests of the evening, Mr. R. S. Brookings, Dr. Graham Lusk, Dr. J. George Adami and Dr. G. Carl Huber.

At the last executive session of the Pharmacological Society a motion was put and passed unanimously to thank the authorities of Washington University for their hospitality and the local committee for its broad and efficient efforts to render the stay of their guests in St. Louis as pleasant and profitable as possible.

The next meeting of the federation will be held in 1915 in Boston at the Harvard Medical School.

John Auer,
Secretary

Rockefeller Institute

SCIENCE

FRIDAY, MARCH 5, 1915

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE VALUE OF ZOOLOGY TO HUMANITY[1]

THE CULTURAL VALUE OF ZOOLOGY

ALL sciences are so interrelated that it is not easy to point out the distinctive contributions of any one science to human welfare, and in particular I have found it impossible to separate zoology from other biological sciences in this regard. Accordingly, in what I shall say it will be understood that I am speaking for all the biological sciences and not for zoology alone.

Again culture is no single definite object, but a general and rather indefinite ideal. There are many kinds of culture—physical, intellectual, moral, esthetic, religious, governmental, etc.—but each and all forms of culture may be regarded from the standpoint of the individual or from that of society; the former we call education, the latter civilization.

I. CONTRIBUTIONS OF BIOLOGY TO EDUCATION

The method of the scientist is to generalize only from particular objects or phenomena, and a naturalist, if asked what the cultural value of biology is, would ask to see some of the specimens. The members of this society are my specimens, my living exhibits of the cultural value of biology. What are your distinctive cultural characteristics? To avoid the personal error it would have been well to have asked each one of you to describe the characteristics of some other member of the society, but making allowance for the personal error, I believe that the biologist shows the following qualities:

1. Immense enthusiasm and intense con-

[1] Four papers in a symposium before the American Society of Naturalists, Philadelphia, December 31, 1914.

centration in his work. He desires no vacations except for bug-hunting and collecting. His idea of a good time is to have a day off for work with his microscope. He is a biologist because the tendency within him is too strong to be resisted. He feels that he was born for one work only. In a peculiar sense he has had the baptism of science—he has "renounced the Devil and all his works, the vain pomp and glory of the world," and has devoted himself with singleness of purpose to one particular subject which seems to him the central theme from which all others radiate.

But this very enthusiasm and concentration has its dangers for it is liable to destroy the sense of perspective and proportion. President Lowell has several times referred to a university course, whether real or mythological he does not say, on the "Antennæ of the Paleozoic Cockroach"—a highly specialized course, it must be admitted, and yet probably no more so than many others to be found in our universities. Our opinions regarding the value of any subject are greatly influenced by our knowledge or ignorance of that subject. There are persons who laugh at all foreigners; they think "they are so funny." There can be no doubt that specialization on any subject which is out of the ordinary seems funny to those who think only conventional thoughts. A great biologist was once at a public reception where he looked and doubtless felt much out of place. A society woman tried to engage him in small talk, but he replied, "Madam, the Maryland oyster is being exterminated." The original "Professor Mooner" of the comic papers was probably an old-fashioned naturalist. Intense devotion to work is a fine thing and has cultural value if properly balanced by a true sense of proportion, but the effect is otherwise if this concentration blots out for one the rest of the universe.

The evil effects of over-specialization are shown in many ways among biologists—not only in the lack of ability to understand or appreciate many other lines of work, but also by the very prevalent notion that the biologist who engages in economic work or who devotes himself to public service has somehow lost caste, and also by the contrasting opinion held by some "practical" biologists that "academic biology should be classed with embroidery." There are many good biologists in economic work, but there are relatively few in public life, and it is a pity that it is so, for on many biological problems of the highest interest to society the biologist could speak with an authority at least as great as that of the sociologists, who are frequently more sure of our results than we are ourselves, an authority greater than that of the propagandists who invent their own biology. On the other hand, there are a few great leaders in biology who have become teachers and interpreters to the plain people, men who like Huxley, Galton, Metchnikoff and Forel have dared to apply the teachings of biology to social problems, and there are more biologists who would do this if they were not restrained by the fear of losing caste among extreme specialists.

But, after all, concentration and narrowness are by no means characteristic of biologists and are probably to be ascribed to the weakness of human nature rather than to the influences of biology.

2. A second quality which is more truly distinctive of the biologist is to be found in his powers of observation and imagination. Other sciences also train both of these faculties, but in a peculiar sense the living world is an eternal challenge and stimulus to the powers of observation and constructive imagination.

No one can have failed to notice the great interest which all persons show in living objects. Men, women and children will

watch without weariness the movements of living things when they could not be induced to study the pictures of them in a book. Even many of the higher animals show great interest in and curiosity about moving objects which would remain unnoticed if perfectly still. Is not the source of this universal interest in living things to be found in the fact that we recognize in them fellow creatures with feelings akin to our own? Is not the great craze for moving pictures due to the fact that the movements make the pictures live?

Instinctively we recognize the kinship of all living things; instinctively we attribute to them the joy and sorrow, the fear and courage, the love and hate which we also experience; instinctively our curiosity is aroused and our observation and imagination are stimulated. And when we are older grown and have learned more about the "mechanism of life" do we not find that our curiosity, admiration and wonder are increased rather than diminished? Does not the great mystery of life appeal to the biologist even more than to others? I am sure that I represent the experience of every biologist when I say that the living world is a powerful and unfailing stimulus to the faculties of observation and imagination.

3. Biology occupies a unique place among all the sciences in its cultivation of esthetic appreciation and broad sympathies. It was for this reason that the late Professor Blackie said that he would have all young persons taught music and natural history. The naturalist is an artist in spirit if not in technique. It is sometimes a question how to classify the great artist-naturalists of the past such as Leonardo, Chamisso, Goethe and Audubon, and even if in these days of greater specialization the technique of art and of science are rarely combined in the same person the spirit of the two is combined in every naturalist worthy of the name and not infrequently strives to express itself in the figures and plates with which he adorns his scientific papers.

The biologist is thrilled by the beauty, the fitness, the mystery of organisms, and no scientific explanations of this beauty, fitness and mystery can destroy the esthetic appreciation which they cultivate. In the anatomical study of dead bodies there is less of this esthetic sense than in the study of living, moving, sentient beings, and yet was it not Johannes Müller who said "The anatomist should have the eye of an angel, the hand of an artist and the stomach of a pig"?

With this esthetic appreciation of nature there is mixed a broad sympathy with all living things. We can appreciate the feelings of that student who said that before he studied biology he used to try to crush the earthworms on the walks, but now that he had learned something about their marvellous structures and habits he carefully avoided stepping on them. Every ornithologist can appreciate the feeling of St. Francis of Assisi who called the birds his brothers. In this building which is a monument to his ability and energy I can not forget the naturalist Montgomery, who remembered to his dying day "the thrill with which he first heard the song of the blue bird" and who rejoiced that he was a part of immortal nature.

The biologist has his eyes open to the beauties, the joys, the sufferings of living things. What an outrage it is that he is so often pictured as a cruel and bloody monster! His sympathies extend not merely to his humbler brothers, but his human sympathies are broadened and deepened. The real naturalist can not look upon the Germans or Russians or French or English as monsters. He recognizes his kinship not

merely in body, but also in spirit to all of them, and he is able to understand and appreciate and in a measure to sympathize with all men. Hate and distrust are born of ignorance; knowledge brings sympathy. "To know all is to pardon all." Only a broader knowledge of and sympathy with our fellow men can end class and race antagonisms and guarantee a lasting peace. The study of biology, in broadening the sympathies of men and in cultivating esthetic appreciation, occupies a unique place among all the sciences.

These elements of personal culture are not absolutely distinctive of the biologist. Some persons wander into biology whose inherited tendencies are too strong to be overcome by its discipline; some good men in other fields are biologists gone astray; but in general these qualities are characteristic of the biologist.

II. CONTRIBUTIONS OF BIOLOGY TO CIVILIZATION

1. First among all the contributions of science to civilization stands the emancipation of man from various forms of bondage. Science has to a large extent freed civilized man from slavery to environment; it has well-nigh annihilated time and space, it has levied tribute upon practically the whole earth to supply his wants, it has taught him how to utilize the great resources of nature and to a large extent it has given into his hands the control of his destiny on this planet.

In this conquest of nature all sciences have been represented and it is difficult to apportion exactly the credit due to each. This is well illustrated by the various claims which are being made at present as to who built the Panama Canal. It is claimed by Colonel Roosevelt, by the army and navy, by the engineers, by the doctors and sanitarians, and one ought not to forget the workmen from the United States and the Jamaica negroes, though they are saying little about it. That biologists can put in a strong claim can not be doubted when we reflect upon the former French attempt to build the canal and the ravages of malaria and yellow fever which helped to defeat that enterprise. I suggest as a topic for a general debate at the meetings of the American Association for the Advancement of Science at the Panama-Pacific Exposition next summer this question, "Who built the Panama Canal?" I am sure that biology will be able to show that it is entitled to a large share of the credit.

The contributions of biology to civilization are not generally regarded as equal to those of physics, chemistry or engineering, and yet they are many and great and are constantly increasing in importance. Indeed, the debt of civilization to biology is absolutely incalculable, as may be appreciated when one mentions merely the names of some of the biological sciences. as for example, agriculture, animal breeding, bacteriology, experimental medicine, pathology, parasitology, physiology, sanitation. All of the great advances in these fields in recent years are the results of the study of living things, whether that study was done in a biological laboratory or not, and they are therefore the contributions of biology to culture. Indeed, the very continuance of civilization depends upon biology; there were civilizations of the past which went down under the onslaughts of pestilence and famine, as well as of war, and if our civilization is to advance it must rely upon biology to teach improved methods of warding off disease, of increasing and conserving the food supply and of improving the human breed.

2. But the highest service of science to culture has been in the emancipation of the mind, in freeing men from the bondage of superstition and ignorance, in helping man

to know himself. The message of science to mankind has ever been the message of intellectual enlightenment and liberty, "Ye shall know the truth and the truth shall make you free."

The greatest contribution of biology to intellectual emancipation has been the doctrine of evolution, that great theory which has revolutionized all our thinking regarding man and nature. And evolution is the distinctive contribution of biology to civilization, for it was in the living world and especially in the human realm that the doctrine of evolution came as the great emancipator from superstition and ignorance. The greatest theme of evolution is not the origin of species, nor even the origin of living things, but rather the oneness of all life. This is indeed the greatest principle of biology, namely, that through all the endless diversity of the living world there runs this fundamental similarity and unity. We also are living things and all that concerns other forms of life is of direct interest to us. In the lower organisms we see ourselves in simpler and more primitive form; we see man from the standpoint of the whole living world, as superior beings in another planet might look upon us, and as a result we have ceased to a large extent to regard the universe as existing merely for us. In this intellectual revolution we have ceased to occupy a position of solitary grandeur in a little human universe; we have not grown less, but nature has become so much greater that man's relative position in nature has changed.

Contrast the old view of creation, that the universe was made in six literal days, with the revelations of science as to the immensity and eternity of natural processes. Contrast the old view that all organisms arose suddenly by divine fiat with the view that animals and plants and the world itself are the result of an immensely long process of evolution. Contrast the old anthropocentric view of nature and of man with the new biocentric view which evolution has revealed; the old notion that man was absolutely distinct from all other creatures with the new conception of the oneness of life. As Darwin so beautifully says,

> There is grandeur in this view of life with its several powers having been breathed by the Creator into a few forms or into one, and that whilst this planet has gone cycling on according to the first law of gravity from so simple a beginning endless forms most beautiful and most wonderful have been and are being evolved.

Biology has changed our whole point of view as to nature and man and has thus contributed more than any other science to the intellectual emancipation of mankind.

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THE VALUE OF SCIENTIFIC GENEALOGY

FROM out of the middle ages when learning was treasured by encloistered scholastics has come the tradition that science is necessarily esoteric; and that pure science has little or nothing to do with human affairs; and thus is to be contrasted sharply with the humanities. During the past half century anthropology, social as well as physical psychology and psychiatry, and medicine have developed into well-recognized sciences proceeding by methods as objective and experimental as physics or chemistry and contributing to our knowledge of the field lying between the sciences of biology and chemistry; and of behavior and morphology. To-day the man of science is quite willing not only to apply to the human species the laws that have been determined by the study of other organisms, but he is recognizing that man himself is as good material to use in getting at scientific principles as any other species; and that in certain subjects man affords the *best* mate-

rial for scientific investigation, and that the investigation of man gives a peculiar zest to research because the results are so obviously applicable to our human life. No doubt these considerations are responsible for the fact that to-day we are enquiring into the value of scientific genealogy.

Although the copy-book states that man is an animal, it appears that, until recently, zoologists considered that man is an anthropos and they had nothing to do with him. And so long as the work of the biologist was the description of species, or the study of structure this attitude had a certain justification. But a new era has arisen; an era in which for certain studies the old classifications of botany, zoology and anthropology are being disregarded. These studies may be grouped under the head of general biology. This field includes such matters as general cytology (embracing maturation and fertilization), general embryology (including physiology and chemistry of development), genetics, and general physiology (including irritability). And we find that the phenomena of these sciences are the same for *all organisms* and that all may be used to contribute data to these sciences. And now any biologist feels at liberty to use any material, from any "kingdom," for his studies.

Not only in this matter, but in another, a great change has entered the spirit of our dreams. Formerly the zoologist, still cherishing in manhood the childish delight of collecting animals and studying with uninhibited enthusiasm the details of their structure, found it difficult to answer the question that his fellow human beings put to him, "What are your studies good for?" was able to show few points of contact between zoology and human affairs (except the fisheries and some parasites) and so assumed the lofty attitude of esotericism. But now the biologist is dealing with facts whose bearings are appreciated by any fairly well educated layman. Workers in any one of the fields of general biology are apt to be *importuned* by publishers; and there are men, though few in number, who live in luxury by writing books and giving popular lectures on biological topics! We have hardly to urge the importance of biology to humanity.

In no field of biology is there a greater popular recognition of the importance of biological research than in that of genetics. The reality and the bearing of the new science have gained a general recognition; the realization of the limitations of the methods of amelioration and of training and of hygiene have paved the way for such recognition; and to-day people are coming to look at man as the biologist does, namely, as an animal, comprising hundreds of elementary species, whose potentialities for physical, intellectual and moral development differ tremendously.

If there were anywhere a community that was wholly isolated, whose progenitors were exactly or very closely alike and which was highly inbred, then all the members of that hypothetical community would belong to the same species and it would follow that the facts of genetics would have little importance for such a community, and there would be little need in such a community for a scientific genealogy. But, as a matter of fact, the human race is practising what is, perhaps, the biggest experiment in hybridization that the world has ever seen. And this vast experiment is pregnant with possibilities for good or evil so great that they can not be calculated. Any practical breeder who was carrying on such an enormous system of cross breeding and attempted to keep the details in his head would be recognized as guilty of a colossal folly; and no scientific breeder would, of course, be capable of such

a thing. And yet this precious human kind of ours, whose progress is so fateful to the world, goes its blind way, like any jelly-fish, mates almost at random and then, after two or three generations, has lost all knowledge of the matings that have gone before. Of course, the race has got along, somehow, just as the lower animals get along; although we have been burdened with an intelligence sufficient to lead us to interfere with the operation of pure instinct but not sufficient always to interfere wisely. There are those who urge that the matter of marriage selection should be left to instinct; forgetting that in adult man (with his enormous development of the inhibitions) instinct has been so repressed as to have become a very unsafe guide. There are those who adhere to the obviously false doctrine that men are born equal and therefore it really doesn't matter who marries whom. It is, however, easy to show that it does matter tremendously. Also I think it quite within the range of possibilities that it will become incorporated into the mores that persons who are thinking of marrying should learn something about the genealogical history of the proposed parents of their children. And, again, it is highly probable that, after we have learned the method of inheritance of racial traits and can state the consequences (certain or probable) of particular matings, that such precise knowledge will influence human conduct even as a knowledge of the causes of yellow fever has influenced human conduct and has led to a vast reduction in the morbidity from that disease. When our knowledge of the inheritance of racial characteristics becomes fairly complete and widely diffused it can not be doubted that such knowledge will influence many selections of mates.

The fact that the nature of the mating does influence the progeny is well brought out by the study of half fraternities, both those in which the father and those in which the mother is the common parent. The economic and other environmental conditions are as similar as possible; the difference in the progeny is therefore the more readily ascribed to the difference in blood. I have collected many of these cases of double matings; and one of them may serve us now as an illustration.

A man whom we may call John Wolley, born 1668, son of a merchant and his wife (sister of the first rector of Yale College), graduated from Harvard College, entered the ministry and finally settled in a church in southeastern Connecticut. He had no brother who survived infancy, but three sisters who married well. This John married twice. His first marriage was to a widow, Martha *née* Silver. About the Silvers of that day I can learn little; they were apparently quiet, steady folk who took no very active part in the affairs of the community. Martha is described in the town minutes as "that eminently pious and very virtuous matron." This couple had 7 children of whom one died at 9 years, leaving 6—4 girls and 2 boys—to grow up. Of the younger son we know only that he was born, married and died, having held the office of deacon. The other brother, at his father's death, removed to a farm five miles back from the village which his father had received as a testimony of regard from the town. In his will the father asked the son to improve the farm (about 500 acres) thus left him. The son lived on the farm, married a woman of no outstanding name, with 23 others founded a church near by, and died at the age of 44 years, leaving 14 children, of whom the eldest was not yet 19. Of these 14 children, 9 were sons and apparently none died in infancy but of all the nine sons there is nothing of importance to note of any except birth, marriage and

death, and except that one son was a lieutenant in the Revolutionary war and died in battle. The eldest of these 9 sons had 2 daughters and 2 sons. All died in early life, except one son who cultivated the farm, built houses with his own hand, married into a good family and had two sons, born 1789 and 1787, who survived early youth and both of whom became quiet, steady farmers, noted for their common sense and contentment.

The Rev. Wolley, born 1668, of Connecticut, married a second time; this time to a daughter of John Morris, of one of the leading families of New York and New Jersey of colonial times—great landholders from which Morrisania, now in the Bronx Borough, New York City, and Morris County, New Jersey, are named, and from this union there were two sons. The elder of them was Benjamin Wolley, graduated Yale College, 1732, and married a daughter of Jonathan Edwards's sister. He held the highest position the town had to offer, represented the town in the state legislature through 25 sessions and was for a time clerk of the house; was state senator for 8 years, and was judge of probate and county judge to his death. During the Revolution he helped organize the army; was one of the committee of safety for the state and was always consulted by Governor Trumbull and General Washington as one of the wisest counselors in one of our most trying days. During a session of the legislature occurred the "Dark Day" of 1780; when it was proposed to adjourn the legislature on account of the impending judgment day, he opposed the motion on the ground that its duty lay in proceeding and asked to have candles brought in. This Benjamin had a brother Thomas who graduated from Yale College, entered the ministry, took part in the "Great Awakening" of Whitfield, showed signs of extraordinary elation, set out on a tour of evangelization, once addressed an audience for 24 hours and then fell into a depressed state. Again elated, he ran into great extravagances, threw suspicion on ministers who did not sympathize with his work, called on the people to commit to the flames jewelry, rings, their best clothing and various books which were listed on his index expurgatorious. He then returned to a more normal state again, renounced his former methods, and lived a quiet life during the 12 years that he survived.

Benjamin Wolley and the niece of Jonathan Edwards had a son, John, graduated from Yale College, 1770, took an influential position in the Revolution; was in congress for 18 years, and held positions on the most important committees. His only brother (Henry), graduated from Yale, 1779, was in the commissary department of the Revolution; was in legislature, court of common pleas, representative in congress, was on the corporation of Yale College and died in his 39th year. Later descendants include leading merchants, manufacturers and inventors.

Note the tremendous contrast between these two sets of half brothers—the quiet farmer and the unknown brother of the first mating; the statesman and unstable but magnetic revivalist of the second. The contrast of the product of these two half fraternities is also striking and serves to show the far-reaching consequences of marriage selection.

Since the nature of the mating is of such profound importance for progeny, a knowledge of genealogical history is of the greatest moment in connection with marriage selection. The presence of highly undesirable positive (dominant) racial traits in the family of either one of a pair of young people who are becoming interested in one another should be known to both.

If they marry and have children in the face of the knowledge that at least half of their children will have the same undesirable trait, perhaps their poignant regrets or the sad example will make it easier for some couples in the next generation to mingle some intelligence with their wooing.

In still another respect a knowledge of racial traits may well be of advantage, and that is in the training of a child. Vegetable seedsmen usually send with their seeds directions as to the specific culture of the particular variety. Now, different children have all the racial distinctness of different kinds of cabbages or melons, and it is unwarranted assumption that they all have the same capacities to be educated and that there is a single course of education that is best for them all. The time is coming, we may trust, when a teacher shall begin a class with something more from the registrar's office than the names of his pupils, when it will be recognized that the teacher can train his pupils the more intelligently and effectively the more he knows about the racial qualities as depicted in the family histories of the individuals he is to train.

So, too, in assisting a young person to decide on a vocation it is now recognized as useful to have an analysis of the traits of the person, as far as they have been developed. But the wise adviser will want to go farther and to study the family history of the young man to see if it may not suggest undeveloped potentialities and thus help in a decision as to the kind of life work he should undertake.

Admitting the value of a knowledge of the presence and distribution of racial traits in a family the question remains: What form should genealogy take in the future to furnish the desired information? Since families are merely collections of related individuals, what is needed is, for as many members of the family as possible, a record which should comprise not only the usual statements about birth and marriage and also the biographical and social data so commonly found, but, in addition, and above all, physical and mental data including build, proportions, pigmentation, quality of sense organs and other important physical traits, also the mental equipment, tastes for particular occupations, temperament and social reactions. Because of their importance for advice as to the care of the health, the facts of liability to disease, of grave illnesses and of surgical operations should be given and precise cause or causes of death of those who have died. Those individuals who are willing to give more time to their record will find a detailed *analysis of the personality* an absorbing occupation. Guidance in such an analysis may be obtained from the "Outline of a Study of the Self" by Yerkes and LaRue, also from a "Guide to the Analysis of the Personality," by Drs. August Hoch and George S. Amsden, printed in Bulletin No. 7 of the Eugenics Record Office. It takes several hours to make such an analysis and record; but it has to be done only once in a lifetime and perhaps we owe it to posterity to leave behind us such a record. To encourage the making of such records the Eugenics Record Office, at Cold Spring Harbor, distributes free to applicants a schedule which was based in the first instance on Galton's "Record of Family Faculties" and has undergone three revisions. About 20,000 of these schedules have been distributed to individuals, on request. This fact indicates that there is a widespread interest in this country in making a record of family traits.

It is not sufficient, however, that records be made. In order that such records should be of the greatest service to humanity they should be deposited in a central bureau where they are to be kept as confidential

records, but where they will be available in the biological interests of the human race, for both advice in marriage selection and for studying the inheritance of traits. Such a bureau actually exists in the Eugenics Record Office. The obvious necessity of depositing the family history in a central bureau, if it is to be available for eugenical purposes offers for many an insuperable obstacle. They may enjoy recording facts concerning themselves and other members of their family but they could not think of letting them out of their possession. I can sympathize with this feeling. One does not publish the details of one's family history, because, as society is at present constituted, certain of these facts might, if known, interfere with one's standing or advancement in one's social world. This is owing to the presence of scandalmongers and others of pathological and antisocial instincts who like to hold it up against one that he has certain limitations. The fact that the records are held as confidential ought really to meet this objection. And we may hope that society is nearly ready to take a saner view about one's personal responsibility for one's traits. I am in no way responsible for my racial traits, whether they are due to innate tendencies in development or to peculiar conditions of development, for over neither of these have I, in last analysis, any control. And what a strange spectacle does mankind exhibit, each hiding from others, as far as he can, his personal and family traits, like a lot of little children around a Christmas tree, each hiding from the others the gifts he has received lest it appear that his are not as good as another's. This attitude might be regarded as merely childish and trivial were it not that one's personal and family traits do not belong to oneself, but, in so far as one has, or hopes to have, children and grandchildren, they belong to society. For each one of us is a mosaic of racial traits that have come from a union of various germplasms in the past and some of which will pass into the germplasms of future generations, and organized society has a right to know the racial qualities of its human breeding stock, for organized society is the only agency to which can be entrusted the guardianship of the quality of the germplasm of the future. The scientific genealogy of the future will afford society that knowledge of the racial qualities of its breeding stock. Thus the value of scientific genealogy to humanity lies above all in this that it will make it possible to utilize a knowledge of the racial characters carried by the individual for the advancement of the race.

Chas. B. Davenport
Coldspring Harbor, N. Y.,
December 28, 1914

THE EUGENICS MOVEMENT AS A PUBLIC SERVICE

It is coming to be a commonplace statement that we have paid more attention to the production of high-grade breeds of sheep, cattle, swine, and so forth, than we have to that of effective human beings, and this statement gains popular strength as we awaken one by one to the fact that man is, after all, a member of the animal kingdom and subject to its laws. The idea that society should concern itself directly with the improvement of human offspring emanated, as you well know, from Francis Galton, and the movement thus initiated has for some time been known as the eugenics movement. In clearing the ground by way of preparation for actual work, the eugenist has made certain important discoveries. It appears that in many of our civilized populations to-day, the defective classes are increasing more rapidly than any other constituent of the community and that quite aside from the enormous cost that their care entails

upon the public at large, their very growth threatens our civilization with future submergence, if not with annihilation. With this condition confronting us, it behooves us to make every effort to ward off possible calamity, and it has, therefore, become a common duty for us to acquaint ourselves with the nature of the situation, to enquire into such remedies as have been proposed, and to support every measure, both private and public, that gives reasonable promise of staying and correcting an impending evil. In the time allotted to me, it is my intention to bring before you certain aspects of man's nature that seem to me of first importance in establishing a sound basis for passing upon such problems as I have suggested. I shall attempt this from the standpoint of a zoologist, not from that of a eugenist, for the obvious reason that I am not an expert in the field of eugenics. If I fail in this effort you must lay the blame at the door of the retiring vice-president of Section F, who in his kindly way has trapped me in a moment of unwariness for this occasion.

Although we are awakening to the fact that man after all is only one of the millions of animal species on the surface of the globe, we are also well assured that he is a species of very unusual character. The particular traits in which he differs from most other species are to be found in his social habits. As a community builder, a founder of civilizations, he is far in advance of any other animal. One of the results of his social activities in many communities has been the development of institutions for the preservation and care of his less fortunate fellows. Thus asylums, retreats, hospitals, and so forth, have been established by private munificence or public grants. More or less under the protection of these institutions has grown up a body of semidependents and defectives whose increase it is that excites the apprehension of the eugenists. That in the past such individuals have always formed a part of our race can not be doubted, but that they ever showed a tendency to increase comparable with what seems to be occurring at present is highly improbable. The occasion of this increase is not, in my opinion, merely the exigencies of modern civilization; it is at least in part due to the immense spread of humanitarian activities which have characterized the last century of our civilization.

That this increase of an undesirable stock should afford an argument against such humane activities is far from my meaning. To my way of thinking this threatening feature is indicative of a minor defect in the workings of modern humanitarianism, and its correction when discovered and applied will, I believe, put that movement on a stronger footing than ever before.

Biologically considered, the situation is described by a simple formula. Most of us have given up the idea that natural selection is a factor of prime importance in organic evolution. Its operations are not detailed enough to yield with any completeness the finished product as we know it in nature, an organic species. But most of us are also thoroughly convinced that selection is a real factor in the development of animals. Its function seems to be that of the elimination of the obviously unfit. As we look about in nature we meet on every side evidences of the ruthless destruction of the strikingly ill-adapted. Among the savage races, as among the lower animals, the defective individual meets an early end. It is only the humanitarianism of our higher civilization that reaches out and protects in a measure such members of our race. Stated biologically then it may be said that we as social beings have devised means whereby the slight effectiveness of natural

selection as seen among most organisms has been measurably checked for certain groups in the human species. Thus a class of individuals with undesirable traits so far as the community as a whole is concerned are beginning to make an alarming showing.

If the increase of defectives is due in large part to a certain restriction of natural selection, is the solution of this problem the reinstatement of that process by a removal of humane protection whereby the defective members of our communities would suffer an early personal removal? Not at all! In my opinion any step in the direction of a curtailment of social help to the defective individual is a step backward. No community can afford such a move. We are at present well enough equipped in our social provisions to extend to such persons a reasonable measure of protection and training whereby they can arrive at the fullness of their slight powers. And such a treatment of them is in my opinion the only right social course. But if society protects them against the attacks of unkind Nature, it is entirely within the rights of society to see that their numbers shall not increase. Such growth may well be the very undoing of society itself.

The increase of such individuals is an organic rather than a social matter; in some cases the defective is the unquestionable product of a disease-laden environment, but in most instances he is the offspring of a defective stock and his present condition is thus chiefly the result of inheritance. Natural selection would eradicate such a class of defectives by the elimination of the individual before he had reached the reproductive period. But society can accomplish this end in a vastly more humane way. It can surround the deficient individual with a reasonable environment and eliminate only his powers of reproduction. Modern biology and surgery have progressed far enough to make it reasonably certain that sterilization of both males and females may be accomplished with so little initial and subsequent disturbance to the individual, excepting in so far as his reproductive capacity is concerned, that no one can object seriously to this method when legally and humanely employed. Vasectomy in the male and salpingectomy in the female are operations for the removal of the outlet ducts of the reproductive glands and thus by checking the escape of genital products they very usually sterilize effectually the individuals operated upon. They are relatively simple surgical procedures. Since they leave the reproductive glands untouched, they do not involve the important question of internal secretions, and, as might be expected, they have practically no effect on the personality of those subjected to them. They are therefore in every way suited to the purpose at hand. Legislative action looking to their adoption has already been taken in several communities, but it is naturally slow in its accomplishments, for its support requires behind it a certain amount of public opinion that has not yet had time to crystallize. What some of us regard with impatience as over-deliberateness on the part of the public and legislators is undoubtedly due to their ignorance of the seriousness of the actual situation and of the simplicity and effectiveness of the remedies proposed. This part of the eugenics program in no sense contemplates an interference with the liberties of what may be called even a small part of the community. It has only a most limited application. The extent of this application is well expressed by the Whethams in their declaration that "except in the case of the feeble-minded, where state interference is glaringly overdue, probably in the case of hopeless habitual criminals, and possibly in the case of

sufferers from certain types of blindness and deaf-mutism, there is no direction in which, as yet, general interference would be justified." What is sought in this movement is that persons who are such radical defectives through heredity as to be in the nature of public wards should be rendered sterile by as innocuous a means as possible, for, as is well known, such half measures as segregation and the like are too often ineffective. Since society offers a reasonable protection to such individuals, it is, in my opinion, entirely justified in taking this step against those who through irresponsibility would inflict upon it additions to its already too lengthy list of defective members.

But the eugenist is not only concerned with the problem of a humane elimination of the unfit, he is also equally desirous of perpetuating and increasing the most highly gifted in the community. If the best workers and the best thinkers in all lines of modern human endeavor could reproduce their kind in the next generation to the exclusion of the incompetent and the vicious, civilization would make a stride in less than the span of a single lifetime such as it has never done before. The elimination of the strikingly defective members of society, as I have already tried to show, is a reasonable and a humane possibility. Is it also reasonable to expect that the second part of the eugenics program, namely, the reproduction in future of only the best at hand, is likewise biologically possible?

We can approach this question best by asking what constitutes high excellence in any member of the community. Such a member must have the physical qualifications for an ample life during which he must contribute more or less continuously to the welfare of society. He must be physically intact in that he can withstand the wear and tear of daily exertion, and meet successfully the strain of momentary crises; and he must cultivate a range of activities that yields products serviceable and acceptable to his community. Modern society has an ample supply of this type of human being and it remains to ascertain the source of his qualities and capacities and the means by which they are handed on to his offspring. The question resolves itself into one of the nature and amount of human inheritance.

On this point the facts gathered from animal breeding are most illuminating. Without this source of information, it would have been almost impossible to have formed any adequate idea of the nature of human inheritance. We know full well that the animal breeder has steadily improved his various stocks and that these improvements have become permanent heritable properties of the particular strains with which he has dealt. We also know that the work of the trained breeder is not a haphazard enterprise, but a well-directed effort in which the constancy of the product can be counted on with ever-increasing certainty. Once well established, a breed will reproduce itself under almost any circumstances with such completeness and fidelity that we scarcely think of the environment as in any way involved and we ascribe the results without further ado to inheritance. To get a Holstein cow we invariably draw from Holstein stock; we do not seek to create Holstein surroundings; and experience entirely justifies this procedure. To be sure, we recognize important effects from the environment. We all know that underfeeding or overfeeding will have an immediate influence upon growth, but we never turn to factors of this kind to change one stock into another. Holsteins are one breed and Guernseys are another, and their immediate characteristics are matters of inheritance, not of environment.

With this kind of information behind us, and with the growing conviction that man too is an animal, we naturally turn to the problem of populating the world with the feeling that if human reproduction were subject to only a little of the kind of control that the expert breeder exerts over his stock, the advance of the human species in social efficiency might be incalculably great.

But here I must invite your attention again and more closely than before to what constitutes an effective human being. Such a member of society is not only a person physically intact and capable of responding to all the requirements of an enormously complex environment, as the best of our domestic breeds do, but he is one who has gathered to himself an untold wealth of experience far exceeding that of any other animal. Moreover, he has not only within himself this vast store of riches, but he long ago devised an immensely complex system of extraneous records in the form of spoken and written languages by which experience could be preserved, handed on to others, and thus made available in a fashion wholly unique. With language came morals, the arts, science, in short all those features that make up civilization. Thus the older naturalists were justified in a measure in regarding man as a species separate from all the rest of creation, and even we must today admit his very unusual character. When we call to mind this vast array of activities so much more diverse, rich and voluminous than that of any other species, the problem of inheritance in man takes on a very different aspect from that in other organisms.

Although very little is known about the transmission of the enormously complex inheritance of human beings, there are in this process two fairly well established features. First, many qualities, some of which are of a more physical nature like the color of hair or eyes and others of a more functional character like resistance to disease or temperamental conditions, are known to be inherited in man in precisely the same way as the peculiarities of the lower animals are, that is, through the germ. Other possessions, such as language with all its social dependences, are handed on, not through the germ, but by a process of learning, a mode of inheritance which is only most scantily represented among the lower forms. These two types of inheritance, the one characteristic of most organisms, the other more peculiarly human, have gained especial attention in the last few years and have been designated organic and social inheritance, respectively. That they represent distinct and well-defined processes there can be not the least doubt, but what proportion of the total human inheritance is included in each is a matter of much uncertainty.

From the standpoint of genetics these two types of inheritance are of fundamental importance. Organic inheritance is the only kind that can be controlled through the reproductive processes, and its product when normal is the rich natural soil in which civilization flourishes. Social inheritance is the work of the educator, using that term in the broadest sense, and its product when normal is civilization itself. For success it depends first upon a proper organic soil in which to root, and next upon the cultivating influence of a civilized environment. So far as the individual is concerned social inheritance is essentially a process of learning and our whole educational system is devoted to its operations. Since we receive our social inheritance as an acquired character, to use a biological term, and not through the germ, we can be sure that it will never be converted into an organically heritable aggre-

gate. The most we can hope for is that through the operation of organic inheritance, a nervous equipment can be evolved that will enable us to accomplish formal education more effectually and in a briefer time than we do at present, but that the store of facts representing the experience of one individual will ever be transmitted through the germ even in part to another is inconceivable. The future child may receive through the germ increased facility for learning languages, but the words of any particular language can never reach it by this route. They must come to it through the ear or eye, as newly acquired characters, a social inheritance.

With this distinction of organic and social heredity in mind how must we picture the complete process of reproducing effective members of society. Not by purely educative means which often waste themselves on attempts at the improvement of an impossible stock, nor by the exclusive control of reproductive processes which seem to be able at most only to prepare the individual to receive his social heritage, but by a mutual operation of both lines of endeavor. I am aware that there are those who believe that all that society needs for steady improvement is a right alteration in the environment and that reproductive irregularities will then adjust themselves to the improved conditions, and I am also aware that there are others who think that the social control of human reproductive activities will lead most quickly to social efficiency and the environmental changes are without permanent significance. The latter view represents that of the animal breeder pure and simple and would be correct for man were it not that he inherits not only as the lower animals do, organically, but also socially. To distinguish in the daily life of a given individual what is organically inherited from what is social in origin is very difficult. Has the reformed drunkard become a useful member of society because of the advice he took or by reason of a natural power of resistance received through the germ? No one can tell, but many in this class assert that the advice, the social inheritance, saved them, and no ultra-eugenist has been able thus far to prove that such may not have been the case. With examples of this kind before us, it seems almost impossible to determine whether in human progress organic or social inheritance is the determining factor. And perhaps such a question is in reality futile. Both factors are surely at work in the world and in the infinite succession of events that go to mould a human being into an effective social organism, now one, now the other, probably predominates. Though we are not in a position to give the exact weight that should be ascribed to each of these two factors, we can be sure that the placing of all the weight on one to the exclusion of the other is a mistake. Both factors have shared in the production of effective human beings, and so far as we can see both are likely to continue to participate in this operation.

To conclude, eugenics in the service of society is, in my opinion, entirely justified in demanding the sterilization by humane methods of those defectives who are in the nature of public wards, and this practise may be extended as experience dictates. Eugenics in its relation to propagating the best in the community has a fundamental position in that it is concerned through the elimination of the extremely unfit with the delivery of a reasonably sound stock for cultivation, but it is only secondarily connected with the final production of efficient members of society whose real effectiveness is often more a matter of social inheritance than it is of organic inheritance.

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PREPAREDNESS FOR PEACE

An intelligent and interesting presentation within a brief compass of the subject assigned to me, "Modern Methods of Studying the Mind," would require literary skill of such high order that with the chairman's permission we shall undertake the less ambitious task of considering a few generalizations, not technical descriptions of methods of studying the mind, of the same character as those which John Stuart Mill once described as "the common wisdom of common life"; and then try to determine whether the practical application of some of this knowledge would not to a certain degree remedy our present national unpreparedness for peace with honor.

By way of prologue let me remind you that although at least 100,000 years separate us from our Neanderthal ancestor, we have only just begun to take an intelligent interest in the mechanism of the human mind. Philosophers of antiquity as well as of the present have recorded their impressions of an idealized humanity, but the youngest of all the sciences is the study of the activities of living individuals; and the recent birth of this interest partially explains the pessimism expressed by those who have been rudely awakened by current events to an appreciation of the relatively slight progress made by civilization.

This year marks an important chapter in history. To-day the world pays a tax in blood on human ignorance. Protests are made and Heaven is implored to avert the logical consequences for our failure to obey the command "know thyself." Little did we appreciate how ignorant we are in regard to the foundations of character, and the factors that condition it. As our intelligence increases we shall gradually become quite as much ashamed of our ignorance of human nature as we are now shocked by the horrors of war. How do we intend to face the present crisis? Indulge in maudlin sentimentality, become more bitterly denunciatory, shut our eyes to the magnitude of the task and pray, or rise and acquit ourselves like men?

The problems of peace are more difficult to solve than are those of war. Intelligent belligerency represents a lower plane of mental activity than intelligent neutrality. A declaration of war is an indication of the present inadequacy of human intelligence to solve great problems. Shall we succeed or fail in our declared neutrality? In what direction shall we turn for assistance? The tax upon the brain power of the nation in preparing for peace will be greater than in preparing for war.

Is it rational to suppose that the correct answers to the great questions which now force themselves upon our attention will be given by diplomatist, statesman, social reformer, historian or any person who attempts to predict coming events merely by analyzing impressionistic records of human conduct? Should we not turn to those who are attempting to secure a comprehensive knowledge of the human brain, and its mechanism as expressed in character and conduct? "Declarations of war" and "treaties of peace" are the products of cerebral functions. As long as physicians attacked the problems of physiology from the historical point of view little progress was made in explaining the functions of individual organs; and equally futile have been the efforts of those who, ignoring the study of living individuals, go back to historical sources for their information and offer "these records of the dead" as interpretations of the synthesized activities of all the organs of the human body objectively represented in behavior or conduct. Is there any reason why we should be spared the ignominy of reaping that which

we have sown? We still look at the problems of living from a narrow historical point of view, describing its phenomena in terms borrowed from post-mortem records. The present tragedy of which we are spectators may in a double sense be called an historical drama, as it marks another one of man's failures brought about in the effort to apply his meager knowledge of the individual to regulate present politics by past history. One of the beneficent results of the application of modern biologic methods to the study of the mind has been the development of a sense of optimism based on the belief that the constantly growing interest in the study of living organisms is a foundation for the hope that human activities, as the laws governing their organization are more clearly revealed to us, may become subject to intelligent control.

Any rational attempt to become a nation more successful in cultivating peaceful arts than in developing a belligerent spirit predicates more thorough preparation than man has made to undertake the study and control of the mental mechanisms which give rise to obsessions, overvalued ideas, anomalous emotional reactions, jingoism and chauvinism. Never before has there been a greater necessity than the present one of extending our knowledge of the laws governing the activities of the mind. Temporary expedients for the preservation of the world's peace may be suggested by tribunals, senates and parliaments, but hope for the successful and peaceful solution of problems of vital importance to humanity depends primarily upon the success of man's efforts to attain a comprehensive knowledge of his own brain-power, and the methods by which this may be generated and controlled.

Among the signs of the times are evidences of a sentimental desire for peace, but on the other hand there are reasons for doubting whether our brain power is sufficient to attain and maintain conditions that are unfavorable for war. The enumeration of some of our national characteristics give rise to premonitions that in this crisis we shall with commendable promptitude and efficiency discharge our duties to sufferers abroad; and at the same time show an extraordinary disregard for the intelligent direction of many affairs at home. As a people we undoubtedly work best when under the strain of emotional excitement, and this tendency justifies great deliberateness in considering whether we are equal to the task requiring limitless stores of patience and an intelligence sufficiently developed to bring about conditions esential for the preservation of peace. In the interests of humanity it is desirable to distinguish very clearly between the logical thought-processes of intelligent, peace-loving people, and the sentiments of those who declaim against the horrors of war. There are certain innate qualities of the American mind which justify more than an occasional jog to our memories in order to recall the fact that intellectual judgments are largely determined by the character of the underlying emotional reactions; and yet without attempting to organize feeling or sentiment we complacently direct attention to our traditional capacity to look at the problems of life from a very practical point of view, and remain oblivious to the danger that exists in the constant repression of the sentimental side of our natures until some crisis increases the tension to such a degree that equilibrium can only be restored by an explosion.

We shall not be guilty of carrying our methods of introspection too far if we refer to the serious handicap to the cultivation of those qualities of mind which predispose toward the peaceable solution of im-

portant questions that is expressed in the national disregard for the biologic importance of good mental habits. We seldom stay at one task long enough to develop the habits essential for efficient and thorough work, and the same amateurishness characterizes our efforts whether they be in the field of diplomacy, road-building or in organizing a university. If we actually determine to lay substantial and rational foundations for peace, and not erect a temporary structure on the shifting sands of sentiment we should look below the surface for evidences of actual progress towards the realization of these aims; and find them expressed in such an undertaking as the endowment and organization of a great institute for the study of the brain and nervous system, in increased provisions made for research along similar lines in our universities, and in the establishment of departments of education with a view to training teachers to recognize the biologic needs of human beings; as well as in all those rational efforts made to extend or to put into practise our knowledge of the mechanisms by means of which human individuals adjust their lives successfully to the environment in which they live.

The folly of the mariner who goes to sea without a compass is not greater than our own in attempting to solve the problems involving the destiny of our race without any more definite knowledge than is yet possessed of the functions of the brain and nervous system. The optimistic views expressed by the eugenist in regard to the intellectual progress of the human race that will be brought about by selective breeding will be more rapidly realized as soon as we have collected sufficient data concerning the functions of the nervous system to determine what the desirable mental mechanisms are; as well as the nature of the factors conditioning the trends of the mental life. In reading history our attention is chiefly focused upon the behavior of large numbers of human beings, the crowd or mob, and we forget that the activities of the masses can not be interpreted intelligently until the reactions of the individual have been analyzed. History and anthropology can only become vital subjects and potent factors in directing the streams of civilization when interpreted by a more complete knowledge than we yet possess of the intricate mechanisms of the human brain. It is unnecessary to call attention to the fact that the accounts of man's interest in the investigation of hypothetical mental qualities are voluminous, whereas, the records of actual study of the minds of living persons are comparatively few and meager.

The progress made in the study of mental phenomena has been along two general lines. The different organs composing the human machine and their relations to each other have been made the subject of investigation, and in the second place by observation and by carefully gathering experience as to how the machine expresses its activities as a unit in behavior and conduct, a profitable and broad field of enquiry has been opened up. So dominated are many of us by the instinctive tendency to worship at a special shrine or bow down before a fetish that the absence of test-tube or induction coil in studying the problems of human conduct often leads to the supposition that the laws governing mental phenomena are less easily recognized than those conditioning the reactions taking place in a beaker or registered on a kymograph cylinder.

If we turn from trying to estimate the conjectural benefits that might follow the extension of knowledge of the brain to find some practical application for the relatively few facts already brought to light,

we shall be surprised that even this limited store of information has not been put to some practical use. Even in scientific laboratories by utilizing this information the conditions under which research is carried on could be greatly improved. Progress would be more rapid if scientific men estimated successful achievements not only by counting the number of new facts discovered by an investigator, but by measuring the dynamics of human nature and the character of the mental processes by which investigators attained their results. Occasionally the scientific atmosphere becomes so oppressive that we are justified in taking precautions so that anomalous emotional reactions, cynicism, moods of depression and exaltation, over-valued ideas, obsessions, paranoid trends of thought and the maniac's capacity for indulging in invective and controversy, as well as in depreciating the achievement of other persons, may be replaced by more desirable mental mechanism.

The importance of the early formation of desirable mental habits is a principle reiterated so often that it makes many moments unhappy ones during the copy-book age, but the practical application of the doctrine to increase our happiness and efficiency in living is almost ignored by the present educational system in America. A system of education based upon the vital principle that success in living should be measured by the ease with which the human machine works, and not by the amount of cargo stored in the hold, would be of incalculable benefit to our race.

No more effective demonstration that science is common sense at its best is needed than the justification derived from the modern methods of studying mental phenomena of making habit-formation the chief function of elementary teaching, and from this procedure follows a natural and not arbitrary division between school and university; the former would then be recognized as the place in which habit-mechanisms are carefully trained, and the latter a field for trying out under supervision the activities essential for independent thinking, and for offering encouragement to competent persons to contribute to the extension of human knowledge.

If the citizens of this country are animated by a sincere desire to maintain a condition of peace expressing the activities of virile manhood and not the idle dreams of those who are unable to protect themselves against aggression, a well-directed effort should be made to assist those potentially capable of intellectual leadership to develop their mental faculties to the maximum of efficiency. Although leaders of thought may now be classed as among the actual necessities of life, the atmosphere of the American university is distinctly favorable for the growth of dilettantism and mediocrity. These institutions suddenly find themselves called upon to do their share in bringing about a readjustment of civilization hampered by an organization continually modified to meet either the demands of alumni, who for purely sentimental reasons are disinclined to aid actively in carrying out the proposed transformation of college into university or the increasing number of protestations coming from the champions of a hysterical athleticism. The measure of our intelligence as well as capacity to control effusive sentimentalism may be readily gauged by the methods we adopt in attempting to transform the universities into centers from which a spirit of intellectual leadership may be disseminated.

One result of "the splendid isolation" of our universities from each other has been that a chain of fictitious values for both ideas and ideals is established that empha-

sizes to an excessive degree the importance of a single institution and fails to bring home to students the desirability of developing emotional reactions in connection with permanent motives. At an impressionable age the emotional life of college students is sharply focused upon the interests of a single institution and the general drift of the affective undercurrents is so rigidly determined as to make it exceedingly difficult for the individual later in life to cultivate a just sense of discrimination. The dynamic power of constructive imagination depends upon the organization of an individual's activities, so that there should be coordination of feeling, sentiment and volitional response; and it is just this principle upon which so much of the effectiveness of our intellectual efforts depends that is practically not represented in the organization of our universities; and the failure to make this provision often deprives this country of the fruits of the highest forms of intellectual activity.

Mental habits once established, and motives called into play can not as a rule be shifted later in life without seriously restricting the intellectual horizon by the forcible readjustment of the emotional balance; an adaptation which is none the less serious because the individual is not aware of the process. As long as universities are controlled largely by their own alumni and by boards of trustees representing the traditions, beliefs and parochialisms of a single institution it is hardly possible that these institutions will become centers in which the type of personality essential for creative effort in science, art, or literature will receive a hearty welcome or attain full citizenship. The influence of the continental university is often unfortunately restricted by racial prejudice and national boundaries, but the American university is pretty generally hemmed in by the much narrower parochialism of its own alumni.

May we not begin to let a little more oxygen into the university atmosphere so that the energy, enthusiasm and idealism of American life which is already being put to a world test may be wisely directed and not repressed or stifled. Harvard's Back Bay traditions, Yale's fixed belief in the value of New Haven's ideals, Columbia's complacent metropolitanism, Princeton's faith in imported culture, and Pennsylvania's homing instincts all mark commendable mental traits that have served a useful purpose; and probably these qualities would once again become active ferments if they were transferred to new media.

The following plan if carried into execution would probably tend to bring about conditions more favorable than those now existing for the liberation of the energy stored up within our universities, and which is so often wasted without any effort made to convert it into a creative force.

If each university tried the simple experiment of appointing a small number of consulting trustees, members of the faculty of rival institutions, to meet once or twice a year with the home-board they would bring into the discussion of academic problems that sense of perspective and of values which is now so feebly represented; and definite progress would also be made in preparing intelligently both to maintain peace and deserve respect. This change would be the equivalent of a public declaration of intentions to the effect that the universities were prepared to abandon their local traditions and prejudices, to substitute for particularism a sense of nationalism or even a broad world-spirit, and thus they would become more intimately identified with the intellectual life and spirit of our civilization; and then in good time, following the growth of these broader

interests, more intelligent sympathy and active support would be accorded to those who are endeavoring to extend the bounds of knowledge.

In the present world-crisis we are oppressed by the feeling that the old conceptions of truth have failed us, but our despondency is lessened by the realization of the progress which the efforts of investigators must bring when they are heartily approved, sustained and strengthened by universities fully awakened to the necessity for intellectual leadership in the development of the newer civilization.

STEWART PATON

JOHN MUIR

ON the day before Christmas John Muir, geologist, explorer, naturalist, author, joined the great majority. Though seventy-six years old there had been no apparent decay of his remarkable faculties. Nor was there any painful waiting for the end. Death found him almost in the midst of his literary activities, which he had laid aside for a brief interval in order that he might spend the Christmas holidays with one of his daughters in southern California. On the 27th of December a large concourse of friends gathered from near and far at his home near Martinez, California, to hear the last rites spoken over his remains. He was buried, beside his wife, under trees planted by his own hand, in the beautiful family burial-ground among the Alhambra hills.

John Muir was born at Dunbar, Scotland, April 21, 1838. He was the third in a family of seven children. His early education was received at the grammar school in Dunbar. When he was eleven years old his father emigrated with his family to the United States. They settled on a farm near Portage, Wisconsin. There he indulged to the full his fondness for the life of the wilderness. His book entitled "The Story of My Boyhood and Youth" gives a pleasing picture of this period of his life. He also developed an extraordinary aptness for mechanical inventions of various kinds. Some of these are described in the same volume. In due time he went to the University of Wisconsin. His university career is best described in his own words: "Although I was four years at the university," he wrote two years ago, "I did not take the regular course of studies, but instead picked out what I thought would be most useful to me, particularly chemistry, which opened a new world, and mathematics and physics, a little Greek and Latin, botany and geology. I was far from satisfied with what I had learned, and should have stayed longer. Anyhow I wandered away on a glorious botanical and geological excursion, which has lasted nearly fifty years and is not yet completed, always happy and free, poor and rich, without thought of diploma or of making a name, urged on and on through endless inspiring, Godful beauty."

It was in the early sixties that Muir started off on those wanderings that finally brought him to California. In the early seventies his first brief communications on Yosemite and the Sierra Nevada began to appear in San Francisco and eastern papers. Soon his articles began to be published in the *Overland Monthly*, *Harper's*, *Scribner's*, the *Century*, and the *Atlantic*. A *Reference List to the published writings of John Muir*, prepared by Professor Cornelius B. Bradley in 1897, contains the dates and titles of nearly one hundred and fifty such articles and communications. At that time he had published only one book, "The Mountains of California," which appeared in 1894. But in "Picturesque California," edited by him in 1888, he had contributed articles on "Peaks and Glaciers of the Sierra," "The Passes of the High Sierra," "Yosemite Valley," "Mt. Shasta," "Washington and Puget Sound," and "The Basin of the Columbia River." In the *Proceedings of the American Association for the Advancement of Science* he was represented by papers on "The Formation of Mountains in the Sierra" (Vol. XXIII.), and "The Post-glacial History of the *Sequoia Gigantea*" (Vol. XXV.).

It seems remarkable now that a man of such

outstanding ability as a naturalist and a writer should not have published his first book until he was in the fifties. But Muir found himself very gradually. He spent long periods in exploring and living among the mountains of the Sierra Nevada. On these trips he endured many hardships and fared very frugally. He made copious notes of all his observations and accompanied them with surprisingly exact and often beautiful drawings. His studies were chiefly of a geological, botanical and physiographical nature. The extent and effects of glaciation in the Sierra Nevada received his particular attention, and he was first among geologists to work toward conclusions, on this subject, which in more amplified form now hold the field.

John Muir was an inveterate traveler. During his earlier years he went on foot through parts of the southern states and Canada. In 1876 he had become a member of the U. S. Coast and Geodetic Survey and visited Alaska, where he made many canoe trips and explorations. The great Muir Glacier, which he discovered, bears his name. In 1878 he visited the Arctic regions on the U. S. *Corwin* in search of the De Long expedition, and in 1899 became a member of the Harriman expedition to Alaska. In 1903–4 he visited Russia, Siberia, Manchuria, India, Australia and New Zealand. In 1911 he made a trip up the Amazon in South America, and he went to Africa in 1912. All these travels were undertaken for purposes of study primarily, and served to enrich still further his large stores of knowledge.

The publication of his book on *The Mountains of California* made him known to the world as a writer of exceptional power. His vivid, easy, poetical style was wrought out slowly and with great care. He refused to be hurried in his work, and rewrote his chapters a dozen times if he thought he could improve them in point of expression. His second book, "Our National Parks," shows his literary style at its best. It appeared in 1901 and reflects his eager activity in the interest of forest preservation and the establishment of national parks and reservations. This was followed by "Stickeen, the Story of a Dog," 1909; "My First Summer in the Sierra," 1911; "The Yosemite," 1912; and "The Story of My Boyhood and Youth," in 1913. A book on his Alaskan explorations was practically completed at the time of his death.

A number of high academic honors came to Mr. Muir in his later years. Harvard University bestowed upon him an honorary M.A. in 1896; the University of Wisconsin an LL.D. in 1897; Yale University a Litt.D. in 1911; and the University of California an LL.D. in 1913. He was one of the founders of the Sierra Club, in 1892, and its president for twenty-two years. The outings for which this organization has become famous were due to his initiative. At the time of his death he was president, also, of the Society for the Preservation of National Parks, and vice-president of the California Associated Societies for the Conservation of Wild Life. It should be noted, too, that he was a member of the Pacific Coast Committee of the American Association for the Advancement of Science, charged with the task of preparing for the San Francisco meeting in 1915.

In the death of John Muir the world has lost one of the most remarkable men of our time. To the last he preserved the eager interest of a child in all the phenomena of nature. His unaffected simplicity and modesty remained unchanged, though fame literally wore a path to his door. He knew how to translate his enthusiasms into human benefits, for no American citizen did more for the establishment of national parks, and the conservation of the great forests of the west. In the concluding chapter of his book, "Our National Parks," his sentences are aflame with the passion of a Hebrew prophet who sees the vision of the coming age and its needs. It may be that the present generation is able to appraise justly the services of John Muir as a naturalist and explorer. John Muir the seer, the writer, the father and guardian of Yosemite, awaits the appraisal of a later and greater day.

WILLIAM FREDERIC BADÈ

SCIENTIFIC NOTES AND NEWS

CHARLES EDWIN BESSEY, head of the department of botany and head dean of the University of Nebraska, distinguished as a leader in botanical research and education, past president of the American Association for the Advancement of Science, died on February 25, in his seventieth year.

ARTHUR VON AUERS, the eminent German astronomer, has died at the age of seventy-six years.

DIRECTOR W. A. CAMPBELL, of the Lick Observatory, president of the American Association for the Advancement of Science, has been elected a foreign member of the Swedish Royal Academy of Sciences, Stockholm.

THE William H. Nichols medal is to be conferred on March 5 on Dr. Irving Langmuir, of the research laboratory of the General Electric Company, at the meeting of the New York Section of the American Chemical Society. Dr. Langmuir will make an address on "Chemical Research at Low Pressures."

ON the occasion of the inauguration of Dr. R. B. von Klein Smid as president of the University of Arizona, the degree of doctor of laws was conferred on Dr. D. T. MacDougal, director of the department of botanical research of the Carnegie Institution, and on Dr. J. W. Fewkes, of the Bureau of American Ethnology.

DR. JOHN C. MERRIAM, professor of paleontology in the University of California, has been appointed to be chairman of a sub-committee on research work on the Pacific coast established by the committee of one hundred on scientific research of the American Association for the Advancement of Science.

DR. W. H. HADOW, principal of Armstrong College, Newcastle-upon-Tyne, and Sir Henry J. Oram, engineer-in-chief of the British fleet, have been elected members of the Athenæum Club, for distinguished eminence in science and public service.

DR. ADELAIDE BROWN, of San Francisco, has been appointed a member of the California State Board of Health, to succeed Dr. O. Stansbury.

DR. LEWELLYS F. BARKER, professor of medicine at Johns Hopkins University, Baltimore, was the guest of honor at the thirty-third annual banquet of the McGill Medical Society, Montreal.

DR. H. P. ARMSBY, director of the Institute of Animal Nutrition of the Pennsylvania College and Station, has been relieved of all undergraduate instruction and will devote his entire time to research in animal nutrition and to advanced graduate instruction.

THE board of trustees of Stanford University has elected to its membership Dr. Ralph Arnold, of Los Angeles, a graduate of the university, and has reelected Mr. William Babcock, a capitalist of San Francisco, and Mr. Charles P. Eells, a lawyer of San Francisco, whose terms recently expired. Dr. Arnold is the second alumnus on the board at the present time, the other being Mr. Herbert C. Hoover, who is now serving as chairman of the Belgian Relief Commission in London. Dr. Arnold graduated from the department of geology at Stanford in 1899, received his A.M. there in 1900, and his Ph.D. in 1902. For a number of years he was engaged in scientific work for the government, being for a time paleontologist of the Geological Survey and later in charge of the survey's oil investigations in California. For the last half dozen years Dr. Arnold has been engaged in private practise in the oil fields of the United States, Mexico and South America. He has recently been withdrawing from technical work to a considerable degree in order to devote himself more fully to research work in the field of paleontology.

MR. A. F. MEYER, associate professor of hydraulics in the University of Minnesota, visited Toronto in February to confer with Mr. Arthur V. White and appear before the international joint commission in connection with the Lake of the Woods investigation. Mr. Meyer is serving this commission as consulting engineer.

MR. JOHN BLACKSTOCK HAWLEY (Minnesota, '87), consulting engineer of Forth Worth, Texas, has been elected president of the Texas

Association of the Members of the American Society of Civil Engineers. At the recent annual meeting of the society Mr. Hawley was elected director.

Dr. T. C. Chamberlin, head of the department of geology in the University of Chicago, and formerly president of the University of Wisconsin, gave a series of lectures in the department of geology of the University of Wisconsin from February 15 to 19, in which he reviewed the Chamberlin-Moulton planetesimal hypothesis of the formation of the solar system, with reference especially to recent work in correlating terrestrial phenomena in the light of this theory. On February 18, Dr. Chamberlin gave a public lecture under the auspices of the Science Club of the University of Wisconsin on "Early Stages of the Earth's History."

Dr. Francis H. Herrick, professor of biology in Western Reserve University, addressed by invitation the legislature of the state of Maine, on February 25, on the subject of "The Preservation and Propagation of the Lobster."

Dr. Graham Lusk, professor of physiology in the Cornell Medical School, recently delivered before the Washington University Medical School two lectures entitled "The Basis of Animal Calorimetry" and "Metabolism in Diabetes."

Sir Charles Augustus Hartley, the distinguished British engineer, died on February 22, at the age of ninety years. Sir Charles devoted most of his career to hydraulic engineering and the improvement of estuaries and harbors for the purposes of navigation. In 1875 he was one of the committee appointed by the authority of Congress to report on the improvement of the Mississippi. In 1884 the British government nominated him a member of the international technical commission for widening the Suez Canal. He was a member of the congress that sat at Paris to decide on the best route for a ship canal across the Isthmus of Panama. He was engineer-in-chief and consulting engineer to the European commission of the Danube from 1856 to 1907.

As was noted in Science several months ago the California Fish and Game Commission is attempting to build up public sentiment as the most efficient means of conserving game. In pursuance of this policy the commission has begun the publication of a quarterly, *California Fish and Game,* which is designed to bring facts regarding game and game conditions to the people of the state. The motto of the publication is "Conservation of wild life through education." The second number of the periodical has just been issued. It contains articles relating to game in California, with departments for editorials, fishery and hatchery notes, conservation in other states, life histories of game birds and mammals, and the relation of wild life to agriculture. Full reports on the work and the monthly expenditure of the California Fish and Game Commission are also given. Dr. Harold C. Bryant, director of the newly formed bureau of education, publicity and research is editor of the periodical.

It is stated in *Nature* that in answer to a question as to typhoid in the army, asked in the House of Commons on February 8, Mr. Tennant, Under-secretary of State for War, said: "Of the 421 cases of typhoid in the present campaign among British troops 305 cases were in men who were not inoculated within two years. In the 421 cases there have been thirty-five deaths. Of these deaths thirty-four were men who had not been inoculated within two years. Only one death occurred among patients who were inoculated, and that man had been only inoculated once, instead of the proper number of times—namely, twice." Replying to criticisms against inoculation made by Mr. Chancellor in the House of Commons on February 9, Dr. Addison pointed out that in the South African war there were 58,000 cases of typhoid—more than an Army Corps—whereas in the great force now in France and Belgium, and after six months, including three months of atrocious weather, there have only been 421 cases among the troops. The total losses in South Africa were 22,000, of which about 14,000 deaths were from diseases and 8,000 of these were from typhoid.

THE *British Medical Journal* states that the hospitals of Canada have been severely affected by the war, and in Montreal it seemed as though the three principal hospitals might have to close their doors. A campaign among the 800 governors of the General Hospital produced $150,000 in two days, sufficient to meet expenses for the next two or three years. The appeal for funds for the Notre Dame and Western Hospitals has been equally successful, and they will remain open at least for some time to come. In Vancouver the staff of the General Hospital have voluntarily agreed to a reduction of from 5 to 10 per cent. in their salaries in order to help the board in its financial difficulties.

ON April 3, 1915, an examination will be held to provide an eligible list for the position of food bacteriologist in the Chicago office of the State Food Commission. The salary at present is fixed by law at $1,800 a year. The limits recommended by the State Civil Service Commission are $150 to $175 a month. The examination will be open to non-residents, as well as residents, of Illinois over twenty-five years of age. The duties of the position involve making bacteriological examinations (and interpreting the results of such examinations) of milk, ice cream, eggs, meat, tomato products, etc., in accordance with the dairy, food and sanitary laws. The applicant should be able to state his opinions briefly and accurately as he may be called upon frequently as a court witness. Education equivalent to graduation in science from a college of recognized standing is required, as well as some knowledge of anatomy, histology and pathology, and some training in animal experimentation. The statement is made from the State Food Commissioner's office that the person employed in this position will be given time to take work in the various medical schools or universities of Chicago so that he may acquaint himself with those subjects with which he is not thoroughly familiar.

ANNOUNCEMENT is made of the establishment for the year 1915–16 in Nela Research Laboratory, National Lamp Works of General Electric Company, of two fellowships in physical research to be known as the "Charles F. Brush Fellowships." These fellowships are offered for the coming year through the generosity of Mr. Brush who desires thereby to stimulate interest in industrial physics and to make it possible for young men to undertake research work in physics in the environment of an industrial plant. The Nela Research Laboratory will provide space and all necessary facilities, and will have general supervision over the investigations, which must be consistent with the normal activities of the laboratory.

FIRE in the national forests of the west in 1914 caused a loss to the government of not quite 340,000,000 board feet of merchantable timber, valued at $307,303, and of reproduction, or young growth of trees, valued at $192,408, according to statistics just compiled by the forest service. There were 6,605 fires, of which only 1,545 burned over an area of ten acres or more. About 77 per cent. of all the fires did damage of less than $100 each. In addition to the losses suffered by the government, timber on state and private lands within the forests, totaling 228,008,000 board feet and valued at $175,302, was lost. The total area burned over was 690,240 acres, of which 310,583 acres were state and private lands. Notwithstanding that it was an exceptionally favorable year for fires, on account of high temperatures, heavy winds and prolonged drought, the average loss per fire was $103, as against $131 in 1911, when there were only about half as many fires. Eighty-five per cent. of the total loss was caused by fires in Idaho, Montana, Oregon and Washington, where more than half the timber in all the national forests stands. Less than one tenth of one per cent. of this timber was affected. Of the 6,605 fires reported, 3,691, or 55.9 per cent., occurred in these states, and of the 99 fires causing losses of more than $1,000 each, 81 were in this region. Lightning was the chief cause, starting 2,032 fires; campers came next with 1,126, followed closely by railroad locomotives, with 1,110. Incendiaries lighted 470 and the rest were attributed to brush burning, sawmills, etc., or their origin was unknown.

UNIVERSITY AND EDUCATIONAL NEWS

The committee on education of the House of Representatives has reported favorably a bill establishing a National University in Washington. According to the bill an initial appropriation of $500,000 would be made. The university would be devoted to research and graduate work and no degrees would be conferred.

In its annual report to the board of education of New York City, Superintendent Maxwell urges the need of appropriating ten million dollars for elementary school buildings in order that all children may be accommodated. There is also said to be immediate need of buildings for high schools and for vocational schools.

Estimates for 1915 appropriations for the Massachusetts College and Station have been submitted for $313,300 for maintenance and additional appropriations as follows: Microbiology laboratory, $67,500; for the completion of the agricultural building, $122,500; new dormitory, $40,000; enlargement of the power plant, $30,000, and minor improvements, $10,000.

In view of the difficulties of foreign travel no fellows will be appointed by the Kahn Foundation for the year 1915–16.

Dr. Horace Grove Deming, for the past three years associate professor of chemistry in the Philippine College of Agriculture, has been appointed professor of chemistry and chief of the department in the University of the Philippines, filling the vacancy occasioned by the death of Dr. Paul Caspar Freer.

Dr. Andrew Hunter, formerly assistant professor of biochemistry in Cornell University, has resigned the position of biochemist, U. S. Public Health Service, in order to accept the chair of pathological chemistry in the University of Toronto.

DISCUSSION AND CORRESPONDENCE

THE HISTORY OF SCIENCE

To the Editor of Science: I desire to express my hearty commendation of Dr. Libby's paper in the "History of Science," published in Science for November 6, 1914. His paper is one of the pioneers in this new and interesting field of thought, and the expression of such ideas needs further encouragement.

It is apparent that the time is fairly well upon us to give some definite consideration to the value and place of the study of the "History of Science," in the curricula of our universities, colleges and technical schools.

That this study represents a strong reactionary movement from the over-materialistic and specializing tendencies of the age in all departments of human progress is evident, and this is especially true in the sciences themselves. This reaction finds its development in the present idealism in the German school of science, where the historical method in the study of the sciences, theoretical and empirical, has been practised.

Two other notable and interesting papers in the past have contributed valuable suggestions, emphasizing two essential pedagogic points of view. The first treated the cultural or intellectual values derived from the intimate understanding of the problems of nature through the scientific method, and the second the historical perspective in the study of the sciences. Dr. Geo. H. Mead,[1] of the department of philosophy, lays special emphasis upon the cultural aspect in the history of science. In the last paragraph of his article he says:

> There is certainly no agent that can carry more profound culture than the sciences, but our science curriculum is poor in what may be called cultural courses in the sciences, and the import of science for culture has been slightly recognized and parsimoniously fostered.

The value and importance of history as a subject, and as a method, in the ordinary culture courses can not be denied; therefore the study of nature or science with the historical basis is equivalent to a power twice as great. And when education as an instrument of progress emphasizes the cultural element, education then becomes a potent force in making and maintaining the civilization of the future.

[1] Science, N. S., Vol. XXIV., September, 1906, pages 390–97.

The second paper, by Professor C. R. Mann,[2] of the education department in the University of Chicago, advances the historical method in the teaching of science, and the fruitful consequences to be brought about.

Some few years ago the writer undertook a study similar to that of Dr. Libby regarding the value of the history of science for the undergraduates of our colleges, and the replies which came from many prominent men in science, education and philosophy were most encouraging. These letters brought forth a universal affirmative reply regarding the value, importance and the future of the subject, and in general substantiated the arguments of the three papers named. To quote from a letter of Dr. Libby, in which he quotes from some one in authority, "the history of science is the very next essential thing in the development of technical education." Possibly the progress has been slow because there exists no satisfactory text-book on the subject in this country. Professor Tyler and Professor Sedgwick,[3] of the Massachusetts Institute of Technology, throw a much needed and encouraging ray of light to workers in this field.

In this country at the present time a number of our universities, colleges and technical schools are offering history of science courses in one way or another. Foremost of these are the universities of Chicago, Harvard, Michigan, Columbia, California, Stanford and the Massachusetts Institute of Technology. There are apparently two types of courses in the history of science, or two methods in treating the subject, namely, the history of a single subject such as physics, chemistry, etc., which is found in most schools; the second type is represented by the course given at Harvard. This is a general or combined course, three hours through the year being divided into physical and biological sciences. This is also conducted as a separate group of studies, thereby giving it more value or importance, and has now been offered for four years by Dr. L. J. Henderson, of the chemistry department. Personally, I believe it is the most satisfactory method in treating such a study as a course, although it depends upon the point of view one takes.

The University of Chicago offers in addition to its separate historical courses of individual sciences, a series of courses in the department of philosophy on the history and development of ancient and modern scientific concepts, which is apparently closely allied to the history of science.

The writer is at present preparing a paper upon the "Present Status of the Teaching of the History of Science in Our Universities, Colleges and Technical Schools." This study will involve a statistical account and comparison of the different courses given in the history of science, the number of hours of lectures, method of treating the course, and other facts bearing upon the tendencies and progress of this subject.

It is encouraging to note that while the bibliographical material upon this subject is very meager, in this country at least, yet sufficient has been accomplished to enable a fair beginning to be made for a working basis. The John Crerar Library, Chicago, has done more than any other agency in developing this important phase. Of course there are a number of foreign bibliographies or catalogues, such as *The International Catalogue of Scientific Literature*, London, *Institute International de Bibliographie* (science section), Zurich, *Bibliographie der Deutschen Naturwissenschaftlichen Literatur*, Berlin, and the *Bibliotheca Mathematica, Zeitschrift für Geschichte der Mathematischen Wissenschaften*, Leipzig.

In France the Paris Academy of Sciences offers each year a prize of two thousand francs for the best essay, memoir or book, original or translated, upon a general or specific subject in the history of science. The most notable instance was when in 1911 the Prix Binoux was awarded to M. Antonio Favaro, the great Italian historian of science, for the publication of the works of Galileo Galilee, and to M. Edmond Bonnett for his "Notes and Memoirs Relative to the History of the Sciences."

[2] "The History of Science, An Interpretation." *Popular Science Monthly*, Vol. 72, April, 1908, pages 313–22.

[3] "The Teaching of the History of Science," SCIENCE, January 1, 1915, pages 26–27.

It is to Germany, however, that the most credit belongs for the development and the work in this field. The number of very excellent texts and treatises in the history of science in Germany is far beyond the production in any other country. German scholarship is here again manifested in both quantity and quality, and Der Deutschen Gesellschaft für Geschichte der Medizin und Naturwissenschaften, organized in 1902, Leipzig, is probably the only organization devoted to the study and fostering of the history of science. The *Mitteilungen* contain a most complete and valuable bibliographical record of articles, memoirs and books in print, also containing originals and translations of historical treatises in science.

Two other publications worthy of notice at this time are the *Archiv für die Geschichte der Naturwissenschaften und der Technic,* Leipzig; and *Isis, Revue Consacrée à l'Histoire de la Science,* published in Belgium (or was published).

In closing, it would seem that in order to lend encouragement and force to aid this new field of investigation great good ought to come from an organization of a section in the American Association for the Advancement of Science, known as the History of Science section.

FREDERICK E. BRASCH

STANFORD UNIVERSITY,
January 16, 1915

SCIENTIFIC BOOKS

The Home of the Blizzard, being the Story of the Australian Antarctic Expedition, 1911–1914. SIR DOUGLAS MAWSON, D.Sc., B.E. J. B. Lippincott Co. Illustrated, also with maps. $9.00 net.

It was thought by many that the acme of antarctic interest had culminated in the record-breaking sled journeys of Shackleton, the attainment of the Pole by Amundsen, and especially in the pathetic tragedy of Scott's latest expedition. It is encouraging to find in the records of Mawson's non-pole hunting explorations novel lines of human endurance, of tragic disaster, and of historical reversion, combined with scientific researches of value to the world. These physical and moral results exacted from the explorers not only the fullest effort of body and mind, but they also obliged the chief, returning as by miracle from death, to face a deficit of nearly $40,000 to pay for his privilege of polar service.

Mawson's expedition, which had the financial support of the Australasian governments, looked to the exploration of antarctic lands in the Australian quadrant—from 90° E. to 180° E.—and their occupancy for scientific observation and research. An intermediate station, wireless equipped and weather observing, was established on Macquarie Island, 850 miles south-southeast of Hobart. Circumstances restricted the parties for the continent of Antarctica to two—the main base at Commonwealth Bay, 67° S., 143° E. occupied by Mawson and 17 men, and the west base on the Shackleton Oceanic Icecap, 66.7° S., 97° E., established by Dr. Frank Wild and 7 men, in January, 1912.

Scientific work was carried out along the principal lines of geographic exploration, geology, biology, meteorology, glaciology, oceanography and magnetism.

Geographic Exploration.—From Mawson's base journeys aggregating 2,400 miles were made, in which King George V. Land was discovered and explored between 138° and 152° E., and from 67° to 70° 30′ S. In one journey a nevé bridge broke and Lt. Ninnis with team and sledge were fatally precipitated into a crevasse hundreds of feet deep, where they disappeared from sight. Mawson and Dr. Mertz were thus stranded over 300 miles from the station, with 6 wretched dogs and food for a week. Manfully accepting the situation, they struggled amid blizzards over frightfully rough ice, killing and eating their dogs as they failed to work. Mertz died of exhaustion 100 miles from home, towards which Mawson struggled in the last stages of bodily weakness, escaping as by miracle through an indomitable will, physical endurance and the finding of a chance cache set up by a search party. From the western base Wild's party discovered and explored Queen

Mary Land, between 101° 30′ E., and Gaussberg, Kaiser Wilhelm II. Land, in 88° 45′ E. By ship and sledge the coast was traced through fifty-five degrees of longitude, and with previous discoveries it is now certain that the continent of Antarctica extends continuously from 86° E. eastward to 158° W. longitude.

At sea Captain Davis discovered Mill Rise, a submarine ridge in about 47° S., south of Tasmania, and Jeffrey Deep, varying from 2,500 to 3,100 fathoms, approximately between 36° to 46° S., and from 110° to 125° E. He also located the continental slope of Antarctica through 55° of longitude.

Magnetism.—Besides regular work at the base stations, field observations were made by each sledge party. The strenuous effort to reach the South Magnetic Pole barely failed by a scant margin of about fifty miles. The party turned back from 70° 36.5′ S., 148° 10′ E., where the dip was recorded at 89° 43.5′, the Magnetic Pole being yet to the southeast.

The standardization of instruments by the Carnegie Magnetic Foundation, and the reduction and treatment of the observations by Dr. Bauer ensure more accurate and definite results than have been before attained. When such discussion appears it is certain that the present conflicting theories regarding the south magnetic pole will be satisfactorily harmonized.

Geology.—Although Antarctica is so covered by ice-caps as to confine geological researches to rare inland nunataks and infrequent stretches of ice-free coast cliffs, yet the general features of both King George and Queen Mary Lands were determined. Abundant red sandstones suggest that the Beacon sandstone formation, with dolorites, associated carbonaceous shales and coaly strata, extend from Adelie Land eastward to Ross sea region. On King George Land, Aurora nunatak, 1,100 feet high, disclosed "highly quartzose gneiss with black bands of schist." Horn Cliff, over 100 feet high had basaltic columns of dolorite 180 feet high.

> The beacons were found to be part of a horizontal, stratified series of sandstones underlying the igneous rock. Bands of coarse gravel . . . were interspersed with seams of carbonaceous shale and poor coal. . . . Several pieces of sandstone were marked by black, fossilized plant remains.

Near Penguin Point, 300 feet high, "the rock was coarse-grained granite, presenting great vertical faces."

In Queen Mary Land, Madigan nunatak, "the rock was of garnet gneiss, traversed by black dykes of pyroxene granulite;" Avalanche Rocks, 600 feet high, "rock mainly composed of mica schists and some granite;" Ross nunatak, "The rock was gneiss, rich in mica, feldspar and garnets;" Bar Smith nunatak rocks "were granites, gneiss and schists." Off the coast in dredging

> Fragments of coal were once more found: an indication that coaly strata must be widely distributed in the Antarctic.

A meteorite was found on the main ice-cap.

Meteorology.—The dominant characteristic of the climate of Adelie Land were the blizzards, which give the title to Mawson's volumes. He says:

> Such wind velocities as prevail at sea-level in Adelie Land are known in other parts of the world only at great elevations. The average wind velocities for our first year proved to be approximately fifty miles per hour.

Hourly records of one hundred miles were not very unusual, and gusts approximating 150 miles per hour were experienced. On May 15, 1912, the average velocity for the 24 hours was ninety miles. Later the reviewer hopes to comment on these remarkable meteorological conditions.

Biology.—Flora is practically non-existent in Antarctica, the brief list being mosses, lichens and algæ. A growth of lichens on red sandstone is reproduced in color as "an example of the most conspicuous vegetation of Adelie Land." As might be expected, the most luxuriant growths were in penguin rookeries. On Gaussberg were "large quantities of moss." Most interesting were the tiny, eye-visible insects found, especially on Horn Bluff, where among the many patches of moss they were caught in myriads. Fresh-water lakes produced low forms of life, mainly microscopic.

Among these were diatoms, algæ, protozoa, rotifera and bacteria.

Bird life was the striking feature of living nature; penguins, petrels, skuas and a new species of prion. Most interesting are the accounts of incubation, nesting, fishing, etc., of the various species. Eggs of practically every variety were obtained, including those of the silver-gray and antarctic petrels, previously unknown. The emperor penguin is the sovereign bird of Antarctica, and both eggs and rookeries are almost unknown. On Haswell Island, off Queen Mary Land, was found a large rookery of the emperors.

> The Emperor penguins had their rookery on the floe, about a mile from the island. The birds covered four to five acres. . . . We estimated the numbers to be 7,500, the great majority being young birds.

Near by was found a large rookery, about 300 birds, of antarctic petrels nesting in gullies and clefts, laying their eggs on the shallow dirt, each having one egg. This island appeared to be a bird's paradise, as there were also large numbers of Cape pigeons, Southern Fulmars, Wilson petrels and snow petrels, while skuas also were present. Of 26 species of birds obtained 6 were penguins, 3 albatross and 7 petrels.

Seal life was abundant during the summer season, consisting of the seal elephant, sea-leopard, Weddell seal, crab-eater seal and the rare Ross seal, of which 6 specimens were obtained. The blue and killer whales were the only varieties observed. Space fails in which to dwell on interesting observations made of bird and of seal life, as well as to the rich and varied marine life procured both by shore-dredging and by deep-sea dredging at 11 stations in depths reaching 1,800 fathoms, and of tow-nettings down to 200 fathoms. The rich fauna and interesting flora of Macquarie Island will prove interesting to scientists. Among these the most important are the rookeries, the sea-elephants having some 500 cows in the largest, the king penguins about 6,000, and the royal penguins covering 26 acres of ground, approximately nearly half a million, as 150,000 birds are killed annually.

Glaciology.—The lands of Adelie, King George and Queen Mary are buried under thick glacial ice, through which protrude rare and small nunataks (ice-free peaks). Not only is the land thus covered, but the continental ice-caps project seaward along the entire coast-line to a greater or less extent. These projections, named by Ross *barriers,* and styled *shelfs* by Mawson, are actually *oceanic* ice-caps. In King George Land Mertz and Ninnis glaciers push seaward indefinite distances, demarcation between land and ocean being undetermined, but each covers more than a thousand square miles of the Antarctic ocean. More remarkable is the Shackleton oceanic ice-cap which covers some 36,000 square miles of the ocean, its dimensions being 180 miles north and south by 200 miles east and west. Its surface extent is approximately equal to the combined areas of the states of New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut and New Jersey. Rising about 100 feet above the sea, its average thickness can not be less than 600 feet. Special interest attaches to the so-called ice-falls, where glaciers of very steep pitch impinge on the oceanic ice-caps, the Denman glacier being an example. Of this Dr. Wild says:

> Denman glacier moving much more rapidly than the Shackleton Shelf, tore through the latter and shattered both its own sides and also a considerable area of the larger ice-sheet. At the actual point of contact was an enormous chasm over 1,000 feet wide, and from 300 to 400 feet deep, in the bottom of which crevasses appeared to go down forever. The sides were splintered and crumpled, towering above were titanic blocks of carven ice. The whole was the wildest, maddest, grandest thing imaginable. . . . Rending the Shackleton Shelf from top to bottom, it presses onward. Thus chaos, earthquake and ruin.

Other polar publications in recent years have been as sumptuously illustrated as are these beautiful volumes, but here is to be noticed a welcome restriction of personal photographic exploitation. The varied experiences of Mawson and of his subordinates, the wealth of sea-life and of bird-fauna, the immensity and peculiarity of glacial forms, have been wisely

utilized for several hundred illustrations which generally are of both popular and scientific interest. Of the 70 views of birds, seals and sea-elephants scarcely one could be spared. The bird-lover finds penguins and petrels of all ages and conditions; the sea-rover will delight in the scenes of seal and sea-elephant life; the meteorologist notes graphic records of winds and blizzards; the biologist sees prophetic shadows of the riches of later scientific publications; and the geologist finds pictured nunataks, columns of dolorite and cliffs of granite. The volumes will be welcome additions to scientific as to other libraries. The index is neither good nor full. Unfortunate was Sir Douglas in the "literary style" due to his associate, as shown in the foreword and by interjected poetry, which mar the dignity of the story of a great and historic expedition.

It is pleasing to find Sir Douglas Mawson in that restricted class that has a due sense of obligation to predecessors. After praising the skill and daring of Wilkes in the hazardous voyage of his squadron for 42 days along the borders of the antarctic circle, he adds:

> It is wonderful how much was achieved. We may amply testify that Wilkes did more than open the field for future expeditions.

Americans thus owe a debt to Mawson, whose faith, courage and ability have given definite form to the 1,500 miles of the continent of Antarctica, which was reported by Wilkes only to be contemned and suppressed in narratives and on charts, and to be absolutely neglected by explorers for seventy years.

A. W. Greely

The Lower Amazon. By Algot Lange. New York, G. P. Putnam's Sons, 1914. 8°, ill., 460 pages.

Mr. Lange's new book shows a great advance over his earlier work entitled "In the Amazon Jungle" published in 1912. He has evidently learned the Portuguese language, a thing so many other travelers seem to regard as quite unnecessary, and he has apparently reached the wise conclusion that one does not need to go deep into the forests of the upper Amazon in order to see and to learn interesting things. The experiences described by the author were confined mostly to a trip up the Tocantins, but without reaching the region of falls, another up the Mojú a short distance above the lower falls, and another to the Ilha do Pacoval in Lake Arary—all of them near Pará.

Personal experiences are related and illustrated by good photographs taken by the author, while the maps add greatly to the interest of the book. The author has a facile and attractive style, and no one has ever described more truly or more pathetically the poverty, sickness and despair that hang over the villages and rubber camps of the Amazon region.

In spite of the fact that he does not take kindly to the food of the country, the author is no longer a tenderfoot.

From a scientific point of view there is nothing new in the book. The ancient pottery from Marajó, on which he justly lays stress, has been known to the scientific world since 1870, when it was visited by Dr. Barnard, of Cornell University, and a paper on it was published by Hartt in the *American Naturalist* for July, 1871, while a much fuller account of it is given in the *Archivos do Museu Nacional* of Rio de Janeiro, Vol. VI., Rio, 1885.

Those who want to know how the conditions of life and of business in the Amazon Valley appear to one who is personally and freshly familiar with them will find much of interest in the final chapters regarding the conditions, prospects, food, health, and what the government is doing for the people. Those who believe in the boundless agricultural possibilities of the lowlands of the Amazon should read what is said at pages 27 and 387–8 of the great, enormously expensive, and tragic experiment of a North American firm on the Mojú, and the footnote about its final abandonment.

It is a relief to find a book necessarily containing many Portuguese words with so few typographic errors. On the other hand, it is not clear why the author always uses the Spanish word "machete" for forest-knife, or why he speaks of his men as "bucks." The long accent so often used by him on Portuguese words is not Portuguese at all: in the

cases observed it should be replaced by the acute accent. A few words are habitually misspelled, probably because they are not given in the smaller dictionaries: such as *cachassa* for *cachaça, meruhim* for *marui, tracachā* for *tracajá* (111), *chibēh* for *chibé* (115).

JOHN C. BRANNER

STANFORD UNIVERSITY

BOTANICAL NOTES

ANOTHER APPLIED BOTANY BOOK

WE have become so accustomed to looking for a new book, or a new revision of one of his earlier books by Professor Doctor Henry Kraemer, that it will not be a surprise to receive the announcement of another big volume of over eight hundred pages. In this book, which he calls "Applied and Economic Botany"[1] he has in mind the needs of students in technical schools, and agricultural, pharmaceutical and medical colleges. At the same time the work will prove itself to be a valuable reference book for chemists and food analysts, while students in morphological and physiological botany will find much that is helpful in its pages.

In carrying out his plan for making the book useful for these various classes of persons the author wisely first makes a rapid survey of the plant kingdom from Schizophytes, Algae, Diatoms, Fungi and Lichens to Bryophytes, Pteridophytes, Gymnosperms and Angiosperms. With this preparation the student is next given a good course in elementary cytology and histology, bringing the text up to page 298, where one finds a chapter on the outer and inner morphology of higher plants. A short chapter on botanical nomenclature must be especially useful to the particular students for whom the book is designed, as it gives a few of the general laws of nomenclature, and follows these with twenty-nine pages in which over eight hundred botanical names are enumerated and their derivations briefly given.

The three remaining chapters are given to the classification of angiosperms yielding economic products, the cultivation of medicinal plants, and microscopic technique, including reagents and their use. They all have a strong pharmaceutical bias, and yet the student in an agricultural college will find in them very much that will be helpful to him, more, probably, than in many of the books that have a more distinctly agricultural label.

It should be said that while there are many paragraphs and illustrations in this book that are identical with the author's fourth edition of his "Text-book of Botany and Pharmacognosy,"[2] published four years ago, this book is distinct from that, and appeals to a much wider circle of botanical students.

[1] Published by the author, 145 North Tenth St., Philadelphia, 1914. $5.

[2] Lippincott, Philadelphia, 1910.

CYBELE COLUMBIANA

UNDER this title Dr. Edward L. Greene issues a 56-page pamphlet as No. 1, Vol. I., of a new botanical periodical which bears the date of December, 1914. Although it is known that the editor's address is Washington, D. C. (Smithsonian Institution), the publishers are given as Preston & Rounds, Providence; William Wesley & Son, London, and Oswald Weigel, Leipzig. Nor is there a statement of a subscription price, but it is stated on the title page that the price for this part is seventy-five cents, from which one may infer that the cost of the volume may be about three dollars. The same title page also informs us that this is to be "a series of studies in botany, chiefly North American," by the editor, "with occasional articles by others."

This first number opens with six pages of inimitable "explanatory," with reference to the title in which it is intimated that this is likely to be a violet periodical. This suggestion is borne out by the second paper on the "Violets of the District of Columbia, I." (pp. 7–33). Other papers are "Manipulus Malvacearum" (pp. 33–36) by the editor, and "Twelve Elementary Species of *Onagra*" (pp. 37–56, with 5 plates) by H. H. Bartlett.

Of course every systematic botanist will welcome Cybele Columbiana.

SHORT NOTES

MR. PAUL B. SEARS publishes an interesting account of the "Insect Galls of Cedar Point (Ohio) and Vicinity" in the December number of the *Ohio Naturalist.* It is accompanied by four plates in which every gall (63 in number) is figured.

DR. M. T. COOK'S "Report of the Pathologist" of the New Jersey Agricultural Experiment Station, for the year 1913, contains a useful annotated list of the most common diseases of the year, arranged alphabetically by hosts. Apples and potatoes had the most diseases (13 and 12), with sweet potatoes following close with 9, and tomatoes with 7.

DR. G. H. SHULL continues to publish plant-breeding papers, as "Sex-limited Inheritance in *Lychnis dioica,*"[3] and "A Peculiar Negative Correlation on *Œnothera* Hybrids."[4]

HERE may be favorably mentioned A. G. Vestal's "Prairie Vegetation of a Mountain-front area in Colorado"[5] with eight good half-tones and a physiographic map of the region studied (near Boulder).

IN the January number of the *American Naturalist* Professor E. C. Jeffrey publishes a vigorous criticism under the title "Some Fundamental Morphological Objections to the Mutation Theory of De Vries." The writer concludes that "hybridism is the best explanation yet put forward of the peculiar conduct of *Œnothera lamarckiana,* as well as other species of the genus in cultures." Apparently this is also the conclusion reached by Professor B. M. Davis in the same number of the *Naturalist* in his article "Professor De Vries on the Probable Origin of *Œnothera lamarckiana.*"

Two new botanical journals, *Journal of Agricultural Research* and *American Journal of Botany* merit favorable notice here. The first is published by the United States Department of Agriculture, and the second is the official publication of the Botanical Society of America. The first is by no means wholly botanical, and yet the articles dealing with plants, while tinged by some economic coloring, are of interest to the scientific botanist also. The second has taken high rank from the first in the literature of scientific botany. Its office of publication is the Brooklyn Botanic Garden.

IT inspires hope to find that the "part" of the "North American Flora" which appeared December 31, 1914, is the first part of the final volume (34), but this hope of early completion is much dampened when we find that this part brings the total number of pages now printed up to about 2,000, which is only about one ninth of what the whole work will contain. It would not be fair, however, to estimate that since it has taken more than nine years to print this much (one ninth) it will require nine times as long, *i. e.,* about one hundred years, to complete the Flora, for it must be remembered that authors have been at work on most of the volumes for the past ten years, and that we shall soon have a rapid appearance of successive parts. This particular part, which is principally from the hand of Dr. Rydberg, begins the tribe *Helenieae* of the family *Carduaceae,* and carries it into the tenth of the fourteen sub-tribes.

CHARLES E. BESSEY

THE UNIVERSITY OF NEBRASKA

[3] *Zeit. of induktive Abstam. u. Vererb.,* Bd. XII., Heft 5.

[4] *Jour. of Genetics,* Vol. IV., No. 1.

[5] *Bot. Gaz.,* Vol. LVIII., No. 5

SPECIAL ARTICLES

A FOURTH MALLOPHAGAN SPECIES FROM THE HOATZIN

THE hoatzin is a curious, rather pheasant-like, South American bird, which is the only species in the strongly aberrant family Opisthocomidæ, a family that is usually even ranked as a distinct avian order. This order or family, which is to say, this bird, has long been and still is a puzzle to the classifying ornithologists. Its genetic affinities are quite uncertain, although the approved general practise of the bird books is to put the family into a pigeon-hole next to that of the pheas-

ants or the pigeons, and close to that of the rails. But the hoatzin also shows certain affinities with the plantain-eaters (Musophagidæ) and even, as Beebe points out, with the primitive lizard-tailed bird of the Upper Jurassic slates of Bavaria, the famous *Archæopteryx.*

In 1909 I had the welcome opportunity of examining a number of Mallophaga taken by Mr. C. William Beebe, curator of birds in the New York Zoological Park, from a hoatzin in Venezuela (its native land). I hoped these parasites might afford some clue to their strange host's genetic relationship, in that, if the Mallophaga proved to be kinds characteristic of pheasants, or, indeed, of any other group of birds, this fact might be advisedly taken into account by the systematic ornithologists. For it is quite certain that in many cases the host distribution of the Mallophagan parasites of birds *is* determined primarily by the genetic relationships of their hosts.

The Mallophaga of the hoatzin, representing three species of the parasites, did indeed prove to be characteristic—but, unfortunately, characteristic of the hoatzin! Two were new species, one a *Lipeurus* and one a *Colpocephalum,* belonging not at all to pheasant-infesting groups of *Lipeurus* or *Colpocephalum* species. Indeed the hoatzin's *Lipeurus* manifestly belongs to a group whose other members infest exclusively maritime birds, while the *Colpocephalum* also shows a likeness to two other species of the genus taken from maritime birds, although it is also rather like a third species described from a francolin (African partridge). The third species, a *Goniocotes,* is also recorded only from the hoatzin—Nitzsch found it on the bird fifty years ago—but it is of a genus which is otherwise almost restricted to pheasants. To this extent, and this only, did the parasites of the hoatzin as recorded by me in 1910[1] offer any suggestions as to the taxonomic position of the host.

I have recently had the opportunity of examining a fourth Mallophagan species from the hoatzin. In a collection of Mallophaga miscellaneously taken by Robert Cushman Murphy, of the Brooklyn Institute Museum, in recent years in various places, I find five specimens of a *Læmobothrium* recorded as taken from a hoatzin on the river Orinoco in Venzuela (date not given). Three of the specimens are immature, but two are adult and represent both sexes.

The extraordinary thing about this *Læmobothrium* of the hoatzin is that, although it has been described by Cummings (Bull. Ent. Research, Vol. IV., p. 43, 1913) of the British Museum as a new species it is certainly very closely related to an already known species described under the name *L. setigerum* by Piaget in 1889 from the Cayenne ibis (*Ibis cayennensis*) which is a native of the same general geographic region to which the hoatzin is confined, namely, South America from the Amazon northward. Indeed, my own judgment is that the hoatzin's parasite should rather be called a variety of this species than the representative of a new one. *Læmobothrium setigerum* is a striking Mallophagan species, well-characterized by a group of curious, heavy, flattened and broad, short, spine-like hairs projecting forward from the clypeal margin, and it is certainly a parasite of ibises and cranes, for I have recently described two other varieties of the species from other ibises. One of these varieties, *L. setigerum* var. *africanum,* came from *Theristicus hagedash* from the Kilimandjaro region of East Africa (collected by Sjötedt's Swedish Expedition to Kilimandjaro-Meru), and also from the same host taken near Mfongosi in Zululand by a collector for the Durban (Natal) Museum. The other variety, *L. setigerum* var. *cubensis,* came from a courlan (*Aramus giganteus holostictus*), from Cuba, collected by Mr. C. D. Ramsden.

It is interesting enough to find a single striking Mallophagan at home on a Cayenne ibis of South America, a wood ibis of East Africa and a courlan of Cuba, but the interest becomes excessive when a closely allied species is found on the hoatzin in Venezuela. Is the hoatzin, after all, less of a pheasant or

[1] *Zoologica,* Vol. I., pp. 117–21, Figs. 38 and 39.

a pigeon and more of a water bird than commonly held? It does indeed, as observers have repeatedly pointed out, have a habitat and habits not unlike those of such water-liking birds as ibises and rails. It inhabits trees and undergrowth along rivers and in marshy regions. It makes nests usually in trees over water. The nests are also, says Beebe, the most recent and most careful observer of the habits of the strange birds, hardly distinguishable from those of the guinea herons, and built in the same situations. But all this may, of course, mean nothing as to the bird's phylogeny.

The suggestion that may come from some that my specimens of *Lœmobothrium* from the hoatzin may have come to this host from some Venezuelan ibis or heron host by natural straggling is extremely unlikely for Mallophagan individuals of different bird species. This is only recorded, and practically only possible, among individuals infesting two bird sorts that consort gregariously in considerable numbers and closely. This is not true of the hoatzin, as Beebe's observations make clearly evident. Mallophaga are in only rare instances, outside perhaps of crowded hen-houses and chicken yards, colonies of chimney swifts or swallows, and places of common roosting or other foregathering of many bird individuals of a kind, found *alive* (or even dead) off the body of a bird. They make their migration from host individual to individual on occasions of actual bodily contact of these hosts, as at mating, and in the nest.

So it is practically certain that the hoatzin is host to a Mallophagan kind, which is most nearly related to a species, or, perhaps indeed, is but a variety of the very species, found heretofore only on Old and New World ibises and courlans.

Vernon L. Kellogg
Stanford University

THE TOXICITY OF INSECTICIDES

Certain facts which may be of general importance in physiological investigations were brought to light in a study of the toxicity of insecticides now under way at the California Agricultural Experiment Station.

A very elaborate series of determinations were made on the effect of hydrocyanic-acid gas on scale insect eggs. The plan of the experiment was to separate the eggs found beneath a scale insect into two lots of about equal size, placing them in gelatin capsules, one lot being allowed to hatch without treatment, and the other after being exposed to the gas for a definite time. The species studied lay on the average rather more than a thousand eggs, and each series of experiments included the eggs from a hundred insects. Nearly three hundred series were thus studied, including five different species of scale insects from eleven different localities in California.

Solutions of hydrocyanic acid of varying concentration were placed in closed glass containers and the open capsules containing eggs to be treated were suspended above these solutions. The density of the gas above these solutions is dependent on the concentration and temperature.

After hatching, the capsule was placed under a microscope and an estimate was made of the hatch in each lot, using only the numbers 05, 10, 20, 30, 40, 50, 60, 70, 80, 90, 95, 100 per cent. The following table will show the results of one series.

The upper right-hand corner gives the results with the weakest dose and shortest time. As would be expected, in the opposite corner, there is no hatch and the mean percentages given below show the effects of the different concentrations, the last two or three of which are completely ineffectual since the hatch is the same as the untreated check lots.

The series of means given at the right bring out an entirely unexpected result, apparently showing that the length of time the eggs remained exposed to the gas has very little effect. This is, however, not at all the fact as shown by the curves on the left side of the table.

The average means of 72 series of experiments with the same insect from the same food plant and locality are 58.31, 59.20, 56.10,

PERCENTAGE OF HATCH

European Fruit Scale on Christmas Berry

Duration of treatment	Concentrations 512	256	128	64	32	16	8	4	2	1	Mean	Check
1	0	0	60	50	80	80	0	100	95	0	46½	77½
1.6	0	0	90	80	0	0	80	0	95	30	37½	79½
3	0	5	90	80	10	90	0	100	80	80	53½	83
6	0	30	60	0	0	0	50	50	100	20	31	82½
11	0	0	0	60	0	20	0	100	100	80	36	79
20	0	20	5	0	80	30	60	100	95	95	48½	72½
35	0	0	0	10	0	60	0	100	10	90	27	69½
59	0	0	0	50	50	100	90	100	95	95	58	80½
98	0	0	0	0	0	20	60	100	50	100	33	75
160	0	0	0	20	0	20	50	100	50	100	34	74½
Mean	0	5½	30½	35	22	42	39	85	77	69	40.5	
Check	88½	75	74	61½	65½	68½	96½	98	77	69		77.35

54.30, 52.20, 50.10, 48.50, 48.01, 46.51 and 43.30, respectively.

In all such experiments individual variation will be very pronounced, but averages based on as large a number of series as this are quite dependable, and we can safely say that long continued action of cyanide at a strength below that producing fatal results exerts on the contrary a benign influence.

It will be remembered that fatal results follow, as a rule, from weaker doses when the time of exposure is long, but far short of the theoretical proportion that would follow on the assumption that the toxicity was dependent on the amount of gas absorbed and that this varied directly as the time and density.

The possible explanation used on the assumption of the production of antibodies within the egg can only partially, if at all, account for the facts since another phenomenon, the acceleration of the rate of development resulting in an earlier hatching, is also evident.

The quickened cell activities indicate that the effect of cyanide, at least in light doses, is to increase cell permeability, a process of rejuvenescence which may be specially useful in an insect's egg so full of yolk material. Decreased permeability is generally considered the measure of approaching death, but it may be that acute poisons like the strong insecticides produce a violent death of cells by the sudden or excessive increase in catabolism.

A third suggestion which may seem rather bold to offer in the case of animal tissue is the possibility of the nitrogen of hydrocyanic acid being available as food directly utilizable by the protoplasm of the cells. The basis for this suggestion is the fact that in a series of experiments by Mr. E. Ralph Ong. conducted in my laboratory with seeds in hydrocyanic acid solutions, a very remarkable and similar acceleration in time of sprouting was observable when the solution was slightly short of a toxic strength, and these plants developed with all the appearance of having had a strong nitrogen fertilization. There is no doubt of the ability of plant tissue to utilize nitrogen in various forms, and we know of no special mechanism necessary to accomplish this which is characteristic of vegetable protoplasm.

The cyanide produced from hydrocyanic acid absorbed in the tissue of a scale-insect egg when not immediately fatal, but present in considerable quantities may be either utilized as food or act as a disturber of the equilibrium of cell permeability or both and in addition it may cause a reaction bringing about the production of antibodies which will neutralize the poison. One or more of these factors may produce a degree of immunity from

the effects of long continued exposure to hydrocyanic-acid gas and, indeed, counteract the effect to such an extent that the surviving eggs hatch better than those with short treatment in the gas. Both animal and plant tissues thus exhibit very decided evidences of definite cyanide stimulation.

C. W. WOODWORTH
UNIVERSITY OF CALIFORNIA

THE AMERICAN SOCIETY OF NATURALISTS

THE thirty-second annual meeting of the American Society of Naturalists was held in the zoological laboratory of the University of Pennsylvania on December 31, 1914. In affiliation with the society this year were the American Society of Zoologists, the Botanical Society of America, the Society of American Bacteriologists, and the American Psychological Association.

By-law No. 3 of the society was amended to read "The Records of the society shall be published once every three years beginning in 1914. The Records shall contain the constitution and by-laws of the society, the minutes of all meetings held within the period covered, the treasurer's reports, and a full list of members of the society."

An invitation to the society from the Pacific Coast Committee on Zoological Program to participate in the sessions concerned with zoology during the convocation week of the American Association for the Advancement of Science, to be held in August, 1915, received the following action. It was voted that the secretary express the appreciation of the society for the invitation and its best wishes for the success of the Pacific Coast meetings. The American Society of Naturalists suggests that members resident on the Pacific Coast organize, if they so desire, a section of the society in accordance with the provisions of Art. IV., Sec. 3, of the constitution, and that this section in cooperation with the American Association for the Advancement of Science hold a meeting in August, 1915.

There were elected to honorary membership in the society Hugo De Vries and Wilhelm Roux.

The following were elected to membership: W. C. Allee, University of Oklahoma; Charles E. Allen, University of Wisconsin; Cora J. Beckwith, Vassar College; Charles E. Bessey, University of Nebraska; William W. Browne, College of the City of New York; W. A. Cannon, Desert Botanical Laboratory; Ralph V. Chamberlain, Museum of Comparative Zoology; Maynie R. Curtis, Maine Agricultural Experiment Station; John A. Detlefsen, University of Illinois; Dayton J. Edwards, College of the City of New York; Arthur H. Estabrook, Eugenics Record Office; Richard Goldschmidt, Kaiser Wilhelm Institut für Biologie; John W. Harshberger, University of Pennsylvania; Marshall A. Howe, New York Botanical Garden; Hartley H. T. Jackson, U. S. Department of Agriculture; Thomas H. Kearney, U. S. Department of Agriculture; Henry H. Lane, University of Oklahoma; W. H. Longley, Goucher College; Henry Laurens, Yale University; George R. Lyman, U. S. Department of Agriculture; John M. Macfarlane, University of Pennsylvania; Frederick C. Newcombe, University of Michigan; Susan P. Nichols, Oberlin College; Theophilus S. Painter, Yale University; Arthur S. Pearse, University of Wisconsin; Herbert W. Rand, Harvard University; Charles G. Rogers, Oberlin College; Forrest Shreve, Desert Botanical Laboratory; William C. Stevens, University of Kansas; L. B. Walton, Kenyon College; Orland E. White, Brooklyn Botanic Garden.

A cordial vote of thanks was passed to the University of Pennsylvania for its hospitality.

The program of the morning session was as follows:

A. F. Blakeslee and D. E. Warner, "Correlation between Egg-laying Activity and Yellow Pigment in the Domestic Fowl."

A. F. Blakeslee, "A Sexual Mutation in a Vegetatively Propagated Pure Line of Mucors."

Sewall Wright (by invitation), "The Albino Series of Allelomorphs in Guinea-pigs."

H. S. Jennings, C. S. Lashley, A. R. Middleton, F. M. Root and Ruth J. Stocking, "Researches on the Inheritance and the Results of Selection in Uniparental Reproduction."

Edward M. East, "The Phenomenon of Self Sterility." (Read by title.)

Helen D. King, "The Effects of Inbreeding and Selection on the Growth, Fertility and Sex Ratio of the Albino Rat."

H. H. Newman (by invitation), "Development and Heredity in Heterogenic Teleost Hybrids." (Read by title.)

Alice M. Boring, "Data on the Relation between Primary and Secondary Sexual Characters in the Domestic Fowl."

R. A. Emerson, "Somatic Mutations in Variegated Maize Pericarp."

H. J. Webber and C. H. Myers, "Bud Variation within Tuber Lines of the Common Potato."

Clarence C. Little, "The Inheritance of Certain Types of Spotting in Mice."

George G. Scott, "Some Indications of the Evolution of the Osmotic Pressure of the Blood and Other Body Fluids." (Read by title.)

H. D. Fish, "The Increase in Homozygosis which results from Certain Systems of Inbreeding."

The session of the afternoon consisted of a symposium, in joint session with the American Society of Zoology and Section F of the American Association for the Advancement of Science, on the subject "The Value of Zoology to Humanity."

E. G. Conklin, "The Cultural Value of Zoology."

C. B. Davenport, "The Value of Scientific Genealogy."

G. H. Parker, "The Eugenics Movement as a Public Service."

Stuart Paton, "Preparedness for Peace."

H. F. Osborn, "The Museum in the Public Service."

The Naturalists' dinner was held on the evening of December 31, at the Hotel Walton, with one hundred and forty in attendance. The president, Professor Samuel F. Clarke, described the founding and early history of the society, following whom Dr. A. G. Mayer, as retiring vice-president of Section F, gave an illustrated address on "The Research Work of the Tortugas Laboratory of the Carnegie Institution of Washington."

The officers of the Society for 1915 are:

President—Frank R. Lillie, University of Chicago.

Vice-president—Rollin A. Emerson, Cornell University.

Secretary—Bradley M. Davis, University of Pennsylvania (1914–16).

Treasurer—J. Arthur Harris, Carnegie Station for Experimental Evolution (1915–17).

Additional Members of the Executive Committee—Ross G. Harrison, Yale University (1914–1915); Raymond Pearl, Maine Agricultural Experiment Station (1914–16); Henry V. Wilson, Adeline Ames, Department of Agriculture, University of North Carolina (1915–17).

Bradley M. Davis,
Secretary for 1914

AMERICAN SOCIETY FOR EXPERIMENTAL PATHOLOGY

First session Monday, 2 p.m., December 28, 1914. The society was called to order by President R. M. Pearce. Report of council by secretary. The following papers were presented by members of the society:

"Studies on Streptococci," by E. C. Rosenow. Discussion by Drs. Pearce, Wells, Adami and Whipple.

"Observations on the Formation of Antibodies," by Ludvig Hektoen. Discussion by Dr. Karsner.

"Auto-plastic and Homio-plastic Transplantations of Tissues," by Dr. Leo Loeb. Discussion by Drs. Opie, Ulenhuth and Loeb.

"Further Studies in Nitrogen Retention and Renal Function," by Dr. H. T. Karsner. Discussion by Drs. Wells, Pearce, Opie and Karsner.

"Metastatic Calcification," by Dr. H. G. Wells. Discussion by Dr. Adami.

"Studies in Bile Pigment Excretion," by Drs. G. H. Whipple and C. W. Hooper. Discussion by Drs. Wells, Pearce and Whipple.

"The Influence of Diet upon the Progress of Bacterial Infection," by Drs. E. L. Opie, L. B. Alford. Discussion by Drs. Loeb and Wells, Karsner, Whipple and Opie.

Papers read by title:

"The Effect of Previous Intravenous Injections of the Pneumococcus upon Experimental Pneumonia by Intrabronchial Insufflation of the same Organism," by Drs. B. S. Kline and S. J. Meltzer.

"Further Studies Upon the Experimental Production of Leprosy in the Lower Animals," by Dr. C. W. Duval.

At the conclusion of this scientific session the society went into executive session for the election of officers and new members and transaction of business. Dr. Theobald Smith was unanimously elected president for the ensuing year. Dr. G. H. Whipple was elected vice-president for the ensuing year. Dr. Peyton Rous was elected secretary-treasurer for the ensuing year. Dr. R. M. Pearce was elected councillor in place of Dr. Harvey Cushing whose term expired.

The following new members were elected: Dr. James B. Murphy, of the Rockefeller Institute, Dr. L. G. Rowntree, of the Johns Hopkins Hospital, Dr. Richard Strong, of the Harvard Medical School, and Dr. M. C. Winternitz, of the Johns Hopkins Medical School.

On Tuesday afternoon, December 29, at 2 p.m., and Wednesday morning, January 30, 9 a.m., joint meetings of the Physiological, Biochemical, Pharmacological and Pathological Societies were held. The details of these meetings may be found in the proceedings of these respective societies.

George H. Whipple

SCIENCE

Friday, March 12, 1915

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE FUNCTION AND TEST OF DEFINITION AND METHOD IN PSYCHOLOGY[1]

Amid all of the discussion current in the last few years among psychologists the unprejudiced outside observer might think that we were a body of men professing to develop and teach a science who did not know what that science was to deal with and without any idea or with too many ideas as to the methods that should be followed in undertaking to develop our knowledge of the unknown or undetermined subject-matter. Psychology is at once the science of mind, the science of consciousness, the science of experience, the science of behavior. Psychology must be studied only by careful watching of the processes of the individual, by the individual himself; one who does not proceed in this way is no psychologist, no matter how valuable his work may be as physiology or biology or sociology. On the other hand, we are assured by just as devoted and well-recognized psychologists that psychology must deal only with the responses of the individual, with what can be seen from the outside, and that what the first man deals with really has no existence, or at best is entirely irrelevant to the responses, to anything that is of scientific interest. If we are to be taken at our own valuation we are either altogether unfit to carry on the task we have set ourselves or entirely unprepared for it.

As a matter of fact I presume this comes from the youth of the science, at least from taking a definition and formal statements

[1] Address of the Vice-president and Chairman of Section H—Anthropology and Psychology, Philadelphia, December 30, 1914.

of method too seriously. Other sciences have the same trouble with definitions. It would be as difficult to find a single phrase that would mark off physics from chemistry in an absolutely accurate and adequate way as to distinguish psychology from anthropology or human physiology, and quite as difficult to formulate a definition of either chemistry or physics that would satisfy every one, as to define psychology. From most traditional definitions, J. J. Thomson as physicist has no right to be discussing atoms, and similar violations of the sacred rights of physics as defined in the text-books might be cited on the part of men who are generally labeled as chemists. These men, and the better men in the sciences in general, are not interested in phrasing definitions but in solving the problems that their science, or closely related sciences present to them. On our side, much of the discussion, or the liveliness of the discussion, comes from the fact that we assume that the definition must determine the science rather than the science the definition. It is assumed, tacitly, to be sure, that a definition is logically prior to the science, is a statement from which the science may be deduced or a program that the science is to follow in its development rather than a mere statement of what the science has done, or a formulation, as best we may, of the aims common to the mass of workers who are generally accepted as psychologists.

If we are to accept the view that a definition is the servant of our science rather than its master, if we are to say with Judd "that we all know what psychology is," then the test of a definition is that it shall state the aims of the science in the briefest form possible, and in terms that shall be best understood by the individuals for whom it is intended, that shall be least open to misunderstanding. If we consider the traditional definitions we find that each is open to certain objections when tested by these criteria. The traditional science of mind implies a general agreement as to what mind is, and this is lacking. It also suffers from the implication to men who do not know what psychology is that we are to deal with an entity of some sort, for all terms after they become familiar come to be regarded as denoting things. When mind is defined in a way to avoid this implication, as it usually is in the succeeding sentence, it is no longer recognizable by the uninstructed. The same objections hold against consciousness; it was at first innocent enough of mystical significance, but a very few years of use to designate the material to be studied set it up as a thing or inner force. Hypostatization followed close upon the heels of its entrance into definitions. If psychologists were to study it as the material of their science it must be the equivalent of mind as mind is of soul, it must then be an active agent that psychologists can see, although, like the holy grail, sight of it is granted only to the pure in heart. Experience as a substitute for consciousness or mind escapes some of the disadvantages in that it is less likely to be personified or substantialized, but it is difficult accurately to separate the part of experience that psychology is to treat from that touched upon by the other sciences. When this is accomplished it affords little advantage over mind or consciousness.

In view of all these circumstances a change from the inside to the outside, to describe the object of psychology as behavior, offers the most advantages. Behavior is at once simple enough to require the minimum of definition and is hardly capable of being transformed in meaning to designate a thing or force. It takes, too, the attitude toward the mental of the average non-reflective individual. The ordinary

man is interested primarily in the mind of others rather than in his own. He is interested in furnishing stimuli of various sorts to other men that shall lead or compel them to act in certain ways rather than in how he himself or his fellow feels as he acts. The advertiser is content if his copy induces men to buy, the orator if his discourse brings him votes or changes the mind of his audience to his own opinion. The salesman is content with his knowledge of practical psychology if his patter leads the buyer to part with his money, the general or statesman if he can divine how his opponent is likely to act under the conditions he presents to him. In the simplest as in the most complex and important affairs of life the practical man is concerned not with mental states, but with behavior. He usually assumes mental states to account for behavior, but they are purely hypothetical, not the result of introspection, however crude. Good temper and bad temper, conceit and modesty, weak will and strong will, are all names for qualities that can be recognized through behavior alone, or at least can be no more easily recognized through introspection than by observation. The bad-tempered man is as little aware of it and can give as little explanation for it as his friends or enemies. He knows of his weakness only by observation of his actions rather than by any mental process that precedes or accompanies his acts, and is probably, through his prejudices, even less likely to recognize the quality than are others. To turn in upon one's self, to have "too much contemplation in one's eye," is for the average man a sign of weakness, a forerunner of mental disintegration. The mental states of the uninitiated are not known through watching himself, but assumed to explain the behavior of another man.

On the theoretical side, behavior has the advantage over the more subjective terms as a designation of the subject-matter of psychology that it includes many processes that are treated by practically all of us. Very much of the active life bears very little ascertainable relation to consciousness when closely analyzed. It is not putting the matter too strongly to say that the more the voluntary processes are analyzed, the smaller part does consciousness seem to play in them. The less voluntary processes, habit, instinct and the various impulses are also included in the list of psychological processes, although little or no consciousness accompanies them. They are quite as easily predicted from without as from within. Even the learning processes and the recognition processes are studied quite as easily by observation as by introspection. One knows that one recognizes through observation of his mental states, but sees very little of how he recognizes. One can be almost as sure that another has recognized him as he can that he has recognized the other. Neither can determine immediately how the recognition has taken place. Thinking by the most recent workers would be put on much the same level. Even the self or personality, if one is to use the more familiar and objective term is quite as much removed from introspection as from observation. On the whole, if one were compelled to choose between behavior and consciousness as a designation of the subject-matter of psychology and then should apply the term in all logical strictness, it would be found that more of the actual content of the average text-book on human psychology would need to be eliminated if one deleted the portions that applied to consciousness than if one omitted those sections that were devoted to behavior.

If we leave human psychology and turn to animal psychology, no one would deny

that a study of behavior is all that we have aside from an uncertain amount of discussion as to how closely or remotely the human mind can find a parallel behind the actions of the lower forms. Similar is the problem raised by the assertions of the recently prominent group of philosophers who insist that consciousness is non-existent—at the most an illusion. For them psychology as the science of consciousness has ceased to exist. While fashions in philosophy change too often for the psychologist to attempt to square his definitions with all of them, it is nevertheless interesting to see that psychology defined as behavior is quite as applicable to the philosopher without a mind as to the rest of intelligent creation. His responses to stimulation, his perceptions as they modify his actions, his memory and capacity for reasoning with varying degrees of accuracy under different conditions, even the conditions that led to his denying that he was conscious, could be studied with some degree of satisfaction. Antecedent acts and experience could be shown to give rise to the various actions, and would go far toward explaining them.

But it does not follow that because much of the material in the text-books and much that the common mind regards as mental is really a matter of behavior that a definition of psychology as the science of behavior would change the nature of the science. As was asserted in the beginning, the science makes the definition, not definition the science. There is no mental process, however strictly one may follow the subjectivist, that does not have some influence upon behavior. The very description of them in words itself implies behavior. Perception in all forms, images of all types, feelings and emotions, not to mention the mental antecedents of voluntary action, all play a part in determining the character of the individual. Each modifies his behavior. If one understood thoroughly the behavior of any man he would also understand his consciousness. It is possible to neglect behavior in the study of consciousness, but not to neglect consciousness in the study of behavior. The only ones who could object to the statement that behavior was to be understood in terms of consciousness are the men who deny the existence of consciousness, and they need no convincing as to the possibility or even the desirability of defining psychology as the science of behavior. To my mind, the adoption of behavior to designate the subject-matter of psychology need not change in the least the treatment of the subject as ordinarily presented. Even the individual who finds no interest in anything but the classification of his own mental states, if such there be, could go on with his classification, and, if he classified all of his states, would find an awareness of his own movements among them, and find these very important both as the beginning and the end of his series. He would probably prefer another description, but his own work would be included in the definition, he would still be within the pale. By adopting the definition we change our description of the science not the science itself.

It should be added that in the nature of the case no definition can be satisfactory. No single phrase, or paragraph even, is sufficient to definitely delimit the subject-matter of psychology. Even a short text can not include and describe all that might be and is in reality included in the science. The meanings of terms are bound to grow, and with each change a definition becomes inaccurate. Of course, were one to take the other attitude that the definition fixes the science, the difficulty would be avoided. But there is no absolute authority to fix that definition and even if it could be fixed by such an authority the science would soon

find itself on a procrustean bed. Advance would be impossible. If the science is to determine the definition, the statement can be at best a short-hand description of it, it can do no more than approximate either completeness or accuracy. A definition is no more than a choice of evils. All that is incumbent upon us is that of all evils we choose the least.

Even more the subject of conflict at the present moment than the definition of the science is the question of the methods that may be employed in developing it. On this point psychologists have been even more divided and each more strenuous in insisting upon his own attitudes. Whether a new science attracts the more aggressive and in consequence more intolerant men in the scientific community, or the very uncertainty of the subject of method leads to an over-emphasis of assurance, a whistling to keep up courage, or what the psychoanalyst would call an emotion that arises from the constant repression of a complex of doubt that must be kept below the threshold because of its unpleasantness, it is undoubtedly true that psychologists have spent more time than most scientists in insisting upon their own method or the methods that they have adopted. *Ex cathedra* statements, and assertions that all who do not follow their own method are not psychologists and that all who do follow it and reach results that do not conform with their own are not psychologists, have been relatively very frequent. Several instances may be mentioned. Wundt, as you all know, early in the history of the science asserted that no man who could not obtain the sensory and motor differences in reaction times was to be included among psychologists, and only recently after a controversy with Bühler on the *Ausfrage* method he announced that he would read no more reports on work done by that method. At present Müller and Meumann, both respected leaders in the science, are indulging in a controversy in which each seems to fall back upon similar personal criteria as a justification for their impatience with the standpoint of the other. No psychology without introspection has been a motto frequently implied if not explicitly asserted, and, ironically enough, an advocate of the newest method to claim a monopoly turns upon the former tyrant among methods with the assertion that it has been dealing with an illusory material, that the method is worthless, and that its followers have retarded the development of the science and are in general cumberers of the earth. Turn about is fair play, but to meet intolerance with intolerance is usually more interesting and picturesque than helpful to the science.

To my mind the great difficulty on both sides lies in the same tendency that makes trouble with the definition, the method rather than the science is given priority. The method should be the servant of the science, not the science the slave of the method. The only test of a method is its accomplishment. Just as with definition no authority exists that can once and for all say this is the method, follow it or cease to be a psychologist. Attempts on the part of any one to take that tack are quite certain to be a means of covering the uncertainties or the mistakes of the author; they are certain not to be fruitful for the science. These must have their origin in prejudice rather than in any universal law revealed to that individual alone. Any method that gives results must be kept, and the more we have the better. What are to be called results offers room for difference of opinion, but the gradually developed judgment of the recognized members of the science and of related sciences will be the final arbiter of that question. With

the complexity of our subject-matter any method that can give a point of attack is to be encouraged on general principles. The methods that prove fruitless will disappear soon, the valuable ones will assert themselves. Meanwhile a broad hospitality that will encourage originality, rather than a hidebound insistence upon any single method, will certainly be beneficial for the advancement of the science.

That the advocates of a method are prone to exalt the method at the expense of the science, to make over the science if not the man to conform to the needs of their method, can be seen to-day in the writings of both introspectionists and behaviorists. The introspectionists in general desire to put all the essential mental operations on the inside, to find them in images, while Watson, their newest and most vigorous opponent, would put all on the outside. Thus in the thought processes the more thoroughgoing believers in images insist that thinking that does not go on in images is not thinking, or that the individuals who announce that they do not use images have overlooked their images through faulty observation of some sort. They themselves heap up images for each of the reasoning operations, in spite of the fact that many of the processes they mention are obviously individual if not irrelevant to the end that is accomplished. Watson, similarly, after announcing that psychology is a branch of behaviorism and its method is the observation of external responses under experimental conditions, feels himself compelled to transfer the thinking process in its entirety to the outside where the experimenter can discover all that goes on. Thinking must be found in contractions of the larynx, in slight movements of the larynx, or in other movements at present undiscovered which must however lie upon the surface of the body. It is not apparent why he should insist on the slight movements of the larynx, for which delicate apparatus should be used, rather than upon the full movements of speech which may be even more completely analyzed by the ear. If the language of the individual does not tell us why he reaches certain conclusions when he thinks aloud, I can not see how the slight movements made when he thinks to himself are to be of any greater aid. So far as any evidence on the subject exists, the movements in thinking are but faint replicas of the movements of ordinary speech.

If we take the thinking process as an instance, I am inclined to believe that the great difficulty is not so much with the method as with the way in which it is applied. Advocates of both tend to deal too much with irrelevant materials. As an impartial onlooker I am convinced that much of the imagery that we hear so much of in the long introspective accounts is wholly or largely irrelevant to the problems, and I am sure if I may indulge for a moment in the cocksureness that I am criticizing, that the slight recorded movements that are mentioned on the other side would be at most irrelevant accompaniments, rather than essential conditions of the thought process. If one observe any bit of thinking as revealed in the speech of another or in one's own consciousness, if one happen to have a consciousness, it is seen that there is no difficulty in knowing that a conclusion has been reached and in deciding that it is or is not adequate. How the conclusion is reached, and why it seems adequate or inadequate, is revealed neither to introspection nor to observation. To answer either of these questions one must proceed as one would in the natural sciences by varying the antecedents of each process until one discovers that certain are the real causes and others are chance accompaniments. If experimentation is not

possible, study of the conditions under which the conclusions are reached and of the way the conclusion varies with the immediately preceding events and with earlier experience may give the same result. Heaping up descriptions of accompanying imagery or of accompanying movements may be of no more value to this end than is collecting postage stamps in the study of the causes of events in the world's history. Both may be interesting as mementoes, but throw no light upon underlying causes.

In the list of irrelevancies in connection with the reasoning processes is the question whether one may think without images so much under discussion at the present. Proof that men may think without images is a valuable advance, not in itself, but in so far as it raises the question how he really does think. If two men reach the same conclusion, one with, the other without images, obviously the presence or absence of imagery is equally unessential. The only alternative is to believe that the one man has images, but does not notice them, or that the other thinks in spite of his images. That one thinks and how is the essential, and the individual with the imagery is no more and no less effective in attaining conclusions than the one without. They are equally accurate, and neither knows directly how he accomplishes his results. The quarrel over the nature of the mental state has obscured the more important problems of reasoning. For this reason it seems to me that the important accomplishment of the Würzburg school has been not to prove that thinking may go on without images, although I am prepared to accept that, too, but to show that the antecedent purpose, the *Aufgabe,* determines the course of thought. One shows what is not needed, the other an element that is essential.

From this standpoint the attempt to set up a new element of pure thought rather than to study the actual operations of thinking is unfortunate. All that has been shown by introspection is that images are lacking, not that anything else is present. To assume pure thought is to hypostatize our ignorance. Particularly objectionable is this because no attempts have been made to determine its conditions, to set limits to it, or to reduce it to any law. It is merely another addition to our collection of postage stamps, perhaps even less valuable than the others because denomination and name of the country have been worn off, and no one knows what the remnants of the portrait mean. The great disadvantage with the introduction of the term, is that, as with all names, in the course of a few years all problems of thought, all reasoning operations, will be explained by reference to it. If one asks why John reasons better than Jane the answer will be that John possesses more of the pure thought element. To be sure, none of the advocates of the new school mean anything of the kind at present, and it may never develop in this way, but the tendency to use these more or less mystic entities in mystic ways is strong. A word becomes a thing on the slightest provocation.

By asserting that conscious states may be irrelevant, it is not implied that they are always or even usually irrelevant; in fact, in opposition to Watson it seems to me that many mental states are relevant and that one knows what goes on in mind quite as well or better from the inside than from the outside. Not only does the study of imagery indicate its existence in all but relatively few individuals, but Meumann's and many other studies indicate that it has an important influence upon the method and capacity of an individual's learning, his spelling, the methods of mental calculation and many other activities. To take

a concrete instance, if I may be indulged for a mention of names: Here are Yerkes and Watson who have been working approximately the same time with the same problems and materials and attaining the same conclusions in their chosen field. But recently, when they came to the application of methods to human psychology, one makes much of imagery and of introspection in general, as much as the most ardent introspectionist could wish, while the other denies the existence of imagery except for the sake of argument in a few sporadic cases. If one assume the attitude of the average man and argue from behavior to consciousness, it is evident that while Yerkes has a large amount of concrete imagery, probably dominantly visual, Watson has relatively little concrete imagery, and what he has is of the motor type. An assumption of this sort on the basis of behavior alone, if we are to include writing psychological treatises under behavior, is of course not to be compared in value with a few minutes' introspection, but may be ventured as a guess. If this holds, not only is consciousness and even imagery an essential determinant of behavior, but it is possible to show that one important bit of the behavior of the man who would most emphatically deny the existence of imagery is due to imagery or its lack. To ascertain that one does not have imagery is just as much a contribution of introspection as to determine that it exists. To give over introspection altogether is to abandon the method that has given much if not most of the body of knowledge that we have at present and to insist that we use only a method that so far has been little tried, and which, in the form that is suggested, the inference of mental states from slight movements, has when tested proved relatively futile.

If one broaden slightly the term consciousness and the implication of introspection it seems possible to put the problem of psychology in a form that removes all ground for complaint on all sides. This is to include in consciousness and among ideas the fundamental states upon which all effective mental life depends. More immediate than the image, more certainly made out than any slight movement, is the series of assurances that we have that certain events, subjective or objective, take place. We know that we recall, we are sure that we recognize, believe, see objects, that we are pleased, desire certain things, and are on the point of striving for them. These assurances are common to the man who has images and to the man who has none, to the man who believes that mental life is fundamentally sensory and to him who regards it as altogether motor, to the realist and to the idealist. They might be called mental states, or mental functions, had not both been spoiled by use. It is the mind of the practical man before he does any theorizing. It is likewise the starting point of the psychologist. He begins to deal with images and with slight movements only when he becomes sophisticated, and when he becomes sophisticated he forgets his starting point and substitutes his explanation of consciousness in terms of images, movements, or pure thought for the fundamental reality. In time he assumes that the explanation instead of the fact is the reality, just as the naïve man assumes that memory, attention, will and self are immediately known realities.

My plea is that the real subject-matter of psychology is the fact that we attain conclusions, that we perceive distance, that we are prepared to act, rather than the imagery, or the movements that accompany, precede or succeed. This group of facts common to all schools may be explained in different ways or need not be explained at

all. It is always possible to determine the laws of any mental operation, as has been done by the experiments on memory, by the statistical method applied to everything from heredity to advertising by the Cattell school and others, by the investigators in education, in medicine, in the studies in efficiency, and also in the early experiments on Weber's law and reaction times. Whether classed as conscious processes or as behavior, every one is capable of deciding whether a sound is more intense than the preceding, whether a picture is more or less beautiful than another, of recalling and recording the words that were spoken in a conversation a month ago (whether truly or not is for the experimenter to decide) of pressing a key when a stimulus is given. That is all that these experiments require. How these processes are carried out is entirely indifferent. Granting that they may be carried out, a science of psychology is possible. All disagreement between schools is as to how these judgments are made, that they are made all agree.

This conclusion does not mean that psychology need stop here. How one remembers, the mental antecedents of an act and all questions of classification and of ultimate explanation are bound to be raised and are at once valuable and interesting—my only contention is that the nature of the explanation offered makes no difference to the fact to be explained, a statement that is obvious enough but which seems to be lost sight of in much of the controversy that is raging. The laws that I have been mentioning correspond to the simple physical laws of the lever, of gravitation, Ohm's law and Joule's law, etc., while the controversy rages about questions related to the physicist's discussion of the nature of ether and the atom and the so-called law of relativity. Whether one is to use introspection or observation as the method of psychology arises only when one seeks an explanation of mental laws, not while discovering them. For this explanation introspection, observation and speculation on the basis of both and of knowledge obtained from all related fields can, I believe, all be used to advantage. No one method is complete in itself; in most experiments all three are used, no matter to what school the investigator belongs.

One may take as an instance such an experiment as those of Ach on action with the reaction time method. The fundamental result, let us say, is to determine that the response that follows, showing two numbers written one over the other, depends for its character and the time required upon the purpose. That fact is independent of the method used. If one is interested in the antecedents of the movement in consciousness, one must introspect. But raw products of introspection are valueless. One must be assured that the images are essential by repetition of the introspection with the same individual and other individuals under varying conditions. To determine the nature of the purpose and the way it acts one may see if it has any conscious form, and may indulge in physiological speculations, may look for analogies in physiological laws, or one may observe the bodily attitude, the set of the muscles before and during the response. The final acceptance of any explanation will be found to depend upon a harmony of all these observations with each other and with related facts. In any case, the determination of the laws is related to their explanation as observed fact is related to theory in physics or physiology.

The question might well be raised whether the certainty of recognition, of decision and the other processes we have mentioned as constituting the primary facts of

the mental life, are the products of introspection or observation. On this point there is room for difference of opinion. A large number of the processes, recognition, judgment, feeling, seem to be more closely related to introspection; the active processes, on the other hand, the comparison of divided with accumulated repetitions and perceptions, are either derived from observation or a combination of observation and introspection. In addition to these immediately observed, generally recognized mental states and functions there are immediate facts derived both by introspection and by observation aided by experiment. Such are on the one side the awareness of the different sorts of imagery, the course of association, colored hearing and the different synesthesias, and, on the other, the changes in circulation with mental operations, the slight movements, and the larger movements of expression. These and many other immediate facts of consciousness escape the untrained observer or introspector, but are needed to round out the series of mental facts and to aid in the formulation of expansions of other facts and laws.

In brief then there is room in psychology for the greatest variety of standpoints and for all methods, provided only the spirit of live and let live prevails. The science is above the individual and the individual's preference in definition and method. The definition and method in turn must grow out of the science; they are not given once and for all, and the science forced into them. Given a set of facts and laws of fairly general acceptance, the form of statement again is largely a matter of individual preference guided and tested by the interest and comprehension of the group for whom the discussion is intended. As in most sciences a mixture of explanation and theory with bare fact may be used, or bare facts may be stated and explanation follow or be omitted. Methods that are assumed by the investigators may be with advantage followed in the restatement of their results. But formulation of results and their presentation in a treatise can no more be determined by a priori principles than can the statement of definitions or the prescription of methods. In brief, my plea is for the widest liberty in all respects with a testing of everything by results rather than by formulæ or even by tradition. In the light of the tests so far available it seems to me that defining psychology as the science of behavior and the use of all methods possible under suitable precautions will lead soonest to the end of psychology, the discovery of mental laws and their explanation.

And we have no reason to be ashamed of the progress of the science. More has been done in the discovery of fundamental laws in the last sixty years than in all the preceding centuries from Thales to Fechner, and interesting problems open to our methods of approach on every hand. These laws, the immediate results of experiment, are not in dispute. They have stood the test of repeated investigation, and are accepted on all sides. There is much more difference of opinion about theories, but even here we have made progress. Except for the fact that we still take our theories very seriously, even our theories offer no more occasion for controversy than do theories on similar problems among physiologists, or zoologists or much more than between physicists and chemists.

W. B. PILLSBURY

MRS. HENRY DRAPER

ANNA PALMER DRAPER, widow of Dr. Henry Draper, died on December 8, 1914, at her home in New York City. Her name will always be honorably associated with the science of astro-

physics. It is interesting to note that the wives of two of the men connected with the beginnings of this science played such important parts in the careers of their husbands. Sir William Huggins, who first applied the spectroscope to the stars, had in his wife, the talented Margaret Lindsay, an enthusiastic and capable co-worker during many years of incessant labor. Dr. Draper was also fortunate when, in 1867, he married Mary Anna, the gifted daughter of Courtlandt Palmer, of New York City. For Mrs. Draper not only was her husband's associate in his investigations during the fifteen years of their lives together, but after his early death in 1882, she was able to provide for carrying on his work in a most efficient manner.

It is said that Dr. Draper became especially interested in astronomy in 1857, while attending the meeting of the British Association in Dublin. He was invited by the Earl of Rosse to go with a party to Birr Castle, Parsonstown, to see the famous six-foot reflector. So great was the impression made upon Dr. Draper by this giant telescope that he resolved to construct a similar, although smaller, one for himself. This he did, and in 1867 a reflector of 28-inch diameter was placed in his private observatory at Hastings-on-Hudson. In the summer, Dr. and Mrs. Draper resided at Dobbs Ferry, two miles distant, and it was their custom to drive together to the observatory for the evening work. So great was her interest that he never went to the observatory without her, and in the days of the wet plate, she herself always coated the glass with the collodion. Mrs. Draper told how sometimes after they had been to the observatory and returned to Dobbs Ferry on account of clouds, they would find the sky clearing, and would drive back again two miles to the observatory and recommence work. During the early years of their married life, Dr. Draper was experimenting with the photographs of stellar spectra with his reflector, and in May and August, 1872, he succeeded in photographing the spectrum of Vega, showing four dark lines. This was four years before Huggins obtained a photograph of the dark lines in the spectrum of this star. In 1878, Dr. Draper organized an expedition to go to Rawlins, Wyoming, for the purpose of observing the total solar eclipse of July 29. Mrs. Draper not only went with him, but also assisted in various ways. Her special duty was to count the seconds during the eclipse and lest the vision might unnerve her, she was put within a tent and therefore saw nothing at all of the wonderful phenomenon. Here she sat patiently and accurately calling out the seconds while the glorious and awe-inspiring spectacle was unfolded. Some of us remember her among those gathered on the roof of Hotel Monticello in Norfolk, Virginia, on May 28, 1900, when without instruments we merely observed the total eclipse for its beauty and grandeur. What memories it must have recalled to her of the distant western land where nearly a quarter of a century before she sat inside the tent and called out the seconds for her distinguished husband!

In the winter, Dr. and Mrs. Draper resided on Madison Avenue, New York City. Here he established a laboratory, connected with the residence by a covered passageway, where his work not dependent on the telescope could be carried on, and where his photographs could be studied. The house, which is between Thirty-ninth and Fortieth Streets, is spacious and well adapted to elaborate entertaining. When originally built by Mr. Palmer, it was the last house in New York City, and he was cautioned by his business friends against investing in property so far away from the center. Mrs. Draper remembered when the old omnibus running on Fifth Avenue went only as far as Thirty-ninth Street, so that when any one alighted and started to walk in their direction they were sure of a visitor.

In November, 1882, when the National Academy of Sciences was meeting in New York City, Dr. and Mrs. Draper entertained the members at a dinner said to have been one of the most brilliant ever given there. As a novelty, Dr. Draper lighted the table with Edison incandescent lights, some of which were immersed in bowls of water. About fifty were present, and at the close of the dinner, Dr. Draper, although suffering from a severe cold,

moved about and talked with several of the guests, among others, Professor E. C. Pickering, director of the Harvard Observatory. They discussed in particular the photographs of stellar spectra Dr. Draper had obtained. Professor Pickering expressed to Dr. Draper his great interest in that work and offered to measure these photographs if they could be sent to Cambridge. Almost immediately after the dinner Dr. Draper was seized with a congestive chill, followed by pneumonia which proved fatal a few days later.

Mrs. Draper, who was in deep distress after this sudden loss, desired to establish some memorial to her husband, and for a few years contemplated the erection of an observatory in New York City. This plan proved impracticable, however, and in 1885, she visited the Harvard Observatory, where Professor Pickering was already photographing stellar spectra along the same line as the work which she considered the most important her husband had done. She thereupon decided to found the memorial in connection with the Harvard Observatory, and gave generous sums each year for its prosecution. At first she thought only of continuing the researches on stellar spectra, but in 1887 she decided to extend the plan to include all available facts about the constitution of the stars. She not only gave liberally of her means to carry on this work, but she always took a great personal interest in it. Until deterred by failing health she visited Harvard Observatory regularly, and personally inspected the progress of the work, giving advice about matters of policy, and being greatly interested in the actual inspection of various stellar spectra. All peculiar or new types were submitted to her, and she often exclaimed with girlish eagerness, "How interesting it must be to do it!"

Mrs. Draper was a friend to many scientific men and frequently gave elaborate entertainments in her spacious home. The old laboratory in New York was fitted up as a lecture or exhibition room and could seat two hundred people. Here many famous men came to lecture to scientific societies and invited guests. Here various scientific exhibitions were placed when she entertained such societies as the National Academy or the American Astronomical Society. It is quite unusual for women of wealth to entertain in this manner. Few who have such beautiful homes, have such a desire or interest.

The results of the Henry Draper Memorial have been varied. The first catalogue giving the spectra of a large number of stars was published in 1890, and was called the Draper Catalogue. This contained 10,351 spectra. Following closely upon this came detailed discussions of about 5,000 spectra of the brighter northern and southern stars. In 1911, observations were commenced for a New Draper Catalogue, which will contain the spectra of at least 200,000 stars situated over the entire sky. In this work Mrs. Draper was greatly interested until the very last, and wrote encouragingly about its progress.

In the course of the Draper Memorial work, various discoveries have been made, such as 10 novæ, more than 300 variable stars, 59 gaseous nebulæ, 91 stars of Class O, and a large number of peculiar spectra. Among the greatest results may be mentioned, the establishment of the true order of stellar evolution, and such discoveries as the connection between variability and changes in spectra, the additional series of hydrogen lines, and the existence of spectroscopic binaries.

Who can predict to what further uses the great collection of plates will be put or what further increase in our knowledge of the sidereal universe will be made by means of the generous endowment left in memory of Henry Draper by his devoted and noble wife.

Annie J. Cannon

Harvard College Observatory,
Cambridge, Mass.

A NEW GLACIAL PARK

Announcement has been made through the press of the gift to the New York State Museum of a plot of ground covering seventy-five acres which includes the remarkable Green Lake near Jamesville, N. Y., with its series of abandoned cataracts, rock channels and dry plunge-basins. This spot is not only extremely

picturesque, but now that the significance of its singular conformation has been pretty well worked out by the labors of E. C. Quereau, and more particularly by Professor H. L. Fairchild, it constitutes a very extraordinary, if not unique, geological record.

In the course of Professor Fairchild's work upon the Pleistocene geology of New York state, he demonstrated very clearly and in detail the accuracy of Mr. Quereau's suggestion that in the retreat of the ice mantle the outflow of the glacial waters was by way of tremendous rivers moving eastward into the Mohawk-Hudson drainage, and here one of these streams cut its rock gorge in the limestones of the Helderberg escarpment and left a series of plunge-basins beneath great cataracts which surpassed the dimensions, as they must have equalled the dignity and grandeur, of Niagara.

The Green Lake or Jamesville Lake, which lies on the property now thus reserved, is surrounded on all but its eastern side by an amphitheater of sheer limestone cliffs rising to a height of nearly 200 feet, and the depth of the lake is stated by the former owner of the property to be not less than 100 feet. While water still fills this ancient plunge-basin, it is water of a deep emerald hue, without visible outlet or inlet. Westward of this escarpment is a smaller and dry plunge-basin with its abandoned cataract cliff and with rocky channels connecting it with the larger basin, and from the Green Lake eastward is the old open discharge into the other stream courses and cataracts lying beyond Jamesville in the vicinity of Fayetteville.

Aside from the extraordinarily clear and wonderfully effective geological record displayed in this place, the spot has additional scientific interest as its rocks are the resort of many rare ferns and flowering plants which have long attracted the botanist.

The menace of commerce, expressed in the ever-increasing demand for the conversion of limestone into cement, threatened this wonderful spot, and the intervention of the donor, who saved it from destruction, is a particularly gracious act inasmuch as it conserves a place of high scientific and educational interest.

The property is given to the regents of the university for the State Museum by Mrs. Mary Clark Thompson, of New York, and presented in the name of her father, Myron H. Clark, a former governor of that state, and by her desire it is to be known as the "Clark Reservation."

It may be added that this reservation lies about four miles to the southeast of Syracuse on the Seneca Turnpike, a new state road, and is also easily accessible from Jamesville which can be reached from Syracuse by trolley.

John M. Clarke

Albany, N. Y.,
March 3, 1915

THE UNITED STATES GEOLOGICAL SURVEY AT THE PANAMA EXPOSITION

The exhibit occupies a space 62 by 78 feet in the Palace of Mines and Metallurgy, flanked on one side by the exhibit of the Bureau of Mines and on another by the Alaskan exhibit, for which also the survey has been in a measure responsible. The central feature of the exhibit is a booth, containing stage-like settings of a scene, partly modeled and partly painted. The first represents an undeveloped district in the arid west being studied by the survey. Topographers are at work with their instruments on the headlands; geologists have stripped a bed of coal and are taking a sample for analysis; and other geologists are studying the rocks. In the foreground is an automatic gage beside the river that comes out of the picture toward the observer. Farther back, a stream gager is measuring the stream. In the background is a camp and pack train. The second scene shows the same district after development. The results of the stream gaging have been utilized in planning a power plant that shows in the distance and an irrigation project that covers the valley floor. The coal bed is being mined on one side; an oil field is under development elsewhere; a sandstone bed is being quarried in the foreground; mining and milling are in progress in the mountains; a town has been built, and roads, railroads, and other evidences of civilization abound.

Behind the scenes, in the same booth but

facing the ends, are recessed screens, on one of which are shown pictures illustrating the different kinds of survey work and the part they play in the development of the country. On the other screen are shown several series of pictures.

At one end of the space is shown the per capita production of minerals in the United States in 1880, about the time of the Centennial Exposition, and of the organization of the survey, and in 1913, the period between these dates practically covering the past work of the United States Geological Survey. The exhibit consists of one 97-millionth of the actual production of each mineral in 1913 and one 48-millionth of the production in 1880.

The space along one of the outside aisles is devoted to a series of cases, illustrating what our common things are made of, what the raw material looks like as it is obtained from the earth, and where it occurs in the United States. For example, many of the familiar household articles are there, such as an albuminum saucepan, an electric-bulb filament, and a fountain-pen point; and above each article is shown the mineral from which it is made, traced back to the ore, and then a map of the United States, showing where the ores occur. Most of these individual maps have been prepared especially for this exhibit.

At the west end of the space is an exhibit of the power and fuel resources of the United States, including maps showing the distribution of the black shale from which oil is derived and the apparatus used in the field in determining the shales that are worth studying.

In order to show the transparencies included in the exhibit to the best advantage, arcades resembling mine entrances have been built at the corners of the space. The methods of work in the survey are illustrated by a series of cases showing by a set of partial results how maps are made and other features of the work.

In the portion of the exhibit relating to water resources is a display of automatic gages being run by clock work and recording the fluctuating height of water in a tank.

One feature of the exhibit is the stereoscopic pictures, resembling the old mutoscope views but of a modernized type. These will be arranged in boxes of fifty each on a table at which one may sit and study leisurely various features of survey work. There are also shown four series of pictures of the Grand Canyon and Rocky Mountain region, taken in the early days of the geological survey by the famous photographers Jackson and Hillers.

Other cases show the gem minerals, the rare mineral ores, etc.

SCIENTIFIC NOTES AND NEWS

Col. George W. Goethals has been made a major-general of the line in recognition of his services in building the Panama Canal. Brig.-Gen. William C. Gorgas, surgeon-general, has been made major-general in the medical department. Col. Harry F. Hodges and Lieut.-Col. William L. Sibert, United States Corps of Engineers, have been promoted to be brigadier-generals. The bill providing for their promotions extended the thanks of congress to the officers.

Under the leadership of Dr. Hiram Bingham, the National Geographic Society-Yale University Peruvian Expedition sailed from New York on March 3 to continue its work in the Andean Mountains. Members who left New York on this expedition are: Director, Hiram Bingham, Yale University; geologist, Herbert E. Gregory, Ph.D., Silliman professor of geology in Yale University, geologist of the 1912 expedition; naturalist, Edmund Heller, naturalist of the Smithsonian's African expedition, under the leadership of Colonel Roosevelt; botanist, O. F. Cook, Ph.D., of the United States Department of Agriculture; chief engineer, Ellwood C. Erdis, of the 1912 expedition; topographer, Edwin L. Anderson; chief assistant and interpreter, Osgood Hardy, M.A., of the 1912 expedition; assistant topographer, C. F. Westerberg, B.S., and several assistants.

Miss Katharine Lilly, head nurse of the department of surgery of the Rockefeller Institute for Medical Research, has gone to

France to assist Dr. Alexis Carrel, of the institute, who recently has been detached from the Lyons Hospital and placed in charge of a hospital at Compiègne, France, near the northern line of battle. Dr. H. D. Dakin, the biological chemist, who worked some years in this country, has also joined Dr. Carrel.

PRESIDENT RAYMOND A. PEARSON, of the State Agricultural College at Ames, Iowa, has decided not to accept the offer of Governor Whitman, of New York, to become state commissioner of agriculture to succeed Mr. Calvin Hudson. Dr. Pearson was commissioner of agriculture under Governor Hughes.

MR. WILLET M. HAYES, formerly assistant secretary of agriculture, has returned from a year's service as adviser to the government of the Argentine Republic and of the Province of Tucuman.

DR. and Mrs. N. L. Britton, of the New York Botanical Garden, Mrs. N. Wille, Mr. John F. Cowell, director of the Buffalo Botanical Garden, and Mr. Stewardson Brown, of the Philadelphia Academy of Natural Science, are in Porto Rico engaged in botanical explorations.

DR. JANET T. HOWELL, daughter of Dr. William Howell, professor of physiology in the Johns Hopkins Medical School, has been awarded the Sarah Berliner Fellowship for Women. This fellowship carries with it a gift of $1,000 to enable the recipient to engage in research work in physics, chemistry or biology. Dr. Howell received the A.B. from Bryn Mawr College in 1910, and the Ph.D. from the Johns Hopkins University in 1913. She was holder of the Helen Schaffer Huff research fellowship in physics at Bryn Mawr College during 1913–14 and this year she holds the position of lecturer in physics at Bryn Mawr College, taking the place of Professor James Barnes.

ON February 26, Professor Alexander Smith, of Columbia University, delivered a lecture to the Boylston Chemical Club of Harvard University on "The Forms of Sulphur and Their Relations."

PROFESSOR W. K. HATT, of Purdue University, lectured at the University of Illinois on February 24 on the subject of "Flood Protection in Indiana."

IRA O. BAKER, professor of civil engineering in the University of Illinois, lectured recently before the students of the Short Course in Highway Engineering at the University of Michigan. His subject was "Selecting the Road Surface."

DR. WALTER HOUGH, curator of ethnology, U. S. National Museum, gave an address before the California Academy of Sciences on February 17, on "Explorations of a Sacred Cave in Arizona."

DR. BARTON W. EVERMANN, director of the Museum of the California Academy of Sciences, gave the Sigma Xi lecture at the University of California on February 24. His subject was "The Conservation of the California Elk."

DR. RICHARD MILLS PEARCE, professor of research medicine in the University of Pennsylvania, addressed the Buffalo Academy of Medicine on Wednesday evening, February 24, on "Experimental Studies of the Spleen in its Relation to Anemia, Hemolysis and Hemolytic Jaundice." A reception to the speaker followed the lecture.

WE learn from *Nature* that M. Louis Moissan, son of the late Professor Henri Moissan, and assistant at the Ecole supérieure de Pharmacie at Paris, who died on the field of battle on August 10, has left to his school, in addition to the scientific books and apparatus of his father, the capital sum of 200,000 francs for the foundation of two prizes—one for chemistry (prix Moissan), and one for pharmacy (prix Lugan), in memory respectively of his father and his mother, *née* Lugan.

DR. T. WESLEY MILLS, emeritus professor of physiology in McGill University, died in London on February 14.

PROFESSOR JAMES GEIKIE, the distinguished geologist, died in Edinburgh, on March 2, in his seventy-sixth year. He entered the British Geological Survey in 1861 and was called to the Murchison chair of geology at Edinburgh University in 1882, succeeding his brother, Sir Archibald Geikie.

Dr. Richard Weitzenböck, aged thirty years, docent for chemistry at Gratz, has been killed in the war.

A despatch from Rome states that all physicians in Vienna who are under fifty years of age have been ordered by an imperial decree to join the army medical corps.

The Rockefeller Institute for Medical Research has appropriated $20,000 to be used under the institute's direction to further medical research work under war conditions, and is equipping Dr. Carrel's new hospital in France with apparatus for research work on pathological, bacteriological, surgical and chemical conditions.

The New England Association of Chemistry Teachers held its fifty-second regular meeting on February 27, at the Roxbury Latin School, when an address entitled "Some possible items, new and old, for the course in elementary chemistry," was given by Professor Alexander Smith, head of the department of chemistry in Columbia University. At the request of the executive committee Professor Smith discussed several topics, such as: Action of air in the Bunsen burner flame; colloidal suspensions; cause of valence, electrons; the shortest route to atomic weights; the distinction between physical and chemical change; and new view of a crystalline solid. Several experiments were performed to illustrate these subjects. The members who were present in large numbers discussed the value of these topics in an elementary course in chemistry.

The U. S. Civil Service Commission announces an examination for metallographist, for men only, to fill a vacancy in this position for service in the Engineering Experiment Station, Naval Academy, Annapolis, Maryland, at a salary of $2,500. The duties of this position will be (*a*) to direct the preparation of metal specimens for microscopic examination and the photographing of the same, and to interpret the appearance of specimens under the microscope; (*b*) to prescribe correct heat treatment for steel specimens which have not had proper treatment; (*c*) to make and interpret the various standard physical tests applied to metal specimens; (*d*) to investigate miscellaneous problems that may arise in the course of naval practise, such as the cracking of the tin linings of copper cooking kettles, imperfect welds, various processes of galvanizing, etc.; (*e*) to investigate the properties of various alloys of metal; (*f*) occasionally to make a chemical analysis of metallic substances. The degree of Ph.D. from a college or university of recognized standing, and at least five years' experience since receiving the bachelor's degree, such experience to have included the use of the microscope in the examination of metals, and the making and interpretation of photomicrographs of metals, are prerequisites for consideration for this position.

A systematic study of Missouri River and its tributaries is being carried on by the United States Geological Survey. Considering the varied character of the streams of the Missouri River basin and their great economic value for irrigation, power, and other purposes, the investigation is one of the highest importance. The water supply of this great drainage area is the subject of a publication recently issued by the Geological Survey, entitled "Surface Water Supply of the Missouri River Basin, 1912" (Water-Supply Paper 326), by W. A. Lamb, Robert Follansbee, and H. D. Padgett. This report contains the records of flow at 130 permanent stations of the survey during the year 1912, data which are necessary to every form of water development, whether it be water power, navigation, irrigation, or domestic water supply. Some of the tributary streams are exceedingly variable in flow; others, like the Niobrara in Nebraska, are remarkably uniform. The Missouri proper is formed in southwestern Montana by the junction of three streams which were discovered by Lewis and Clark in 1806 and were named by them Jefferson, Madison and Gallatin rivers. Of these three Jefferson River drains the largest area and is considered the continuation of the main stream. This part of Montana is mountainous and affords many excellent water-power sites. Among the principal tributaries of the Missouri are the Marias, Musselshell, Yellowstone, Cheyenne,

Platte and Kansas. The western part of the basin is in the arid belt and the eastern part is in the semiarid and humid regions. Ten states of the Union are drained in part by Missouri River. Rising at the Red Rock Lakes, at an elevation of 6,700 feet above sea level, this stream descends through the Rocky Mountains and emerges on the broad prairie land a few miles below the city of Great Falls, Montana. From that point it is accounted a navigable stream with an easy grade, and in passing through the Dakotas and along the borders of Nebraska, Kansas and Iowa it receives the flow of great tributaries, so that as it crosses the State of Missouri and joins the Mississippi a short distance above St. Louis it becomes one of the large rivers of the world. Its total drainage area is about 492,000 square miles in extent and comprises, in addition to the states above mentioned, large areas in Wyoming and Colorado and a smaller area in the southwestern part of Minnesota.

THE Michigan College of Mines has received a collection of minerals from the Shattuck Cave, near Bisbee, Arizona, one of the wonders of the mining world. This cave was opened in 1913 by a drift on the third level of the Shattuck Mine. When the miner who had been drifting in this part of the level returned one night after a heavy blast, he found that the working face had entirely disappeared and that before him was a great opening reaching farther than his light would shine. Looking upward he could see tiny lights flashing and believing that they were stars he ran back to the shaft, declaring that he had blasted a hole clear through to surface. Mine officials investigated at once and found that a great natural cavern had been opened up, circular in shape, 340 feet in diameter and 175 feet high. It was a virtual fairyland of beauty, myriads of crystals in the roof reflecting back the lights from the miners' lamps. Walls, roof and floor were covered with great clusters of crystals, and near the center of the cavern a cluster of stalactites hung from the ceiling in the form of a great chandelier 40 feet long. The crystals were for the most part pure white, but in places where the filtering waters had contained iron and copper, the beauty was enhanced by great transparent stalactites and stalagmites, some ruby red, others a clear emerald green or azure blue. The mining company illuminated the cave with electricity and has allowed thousands of visitors the privilege of seeing it. An attempt was made to have the Smithsonian Institution at Washington remove and reproduce a portion of the cave, but nothing came of it. It is because the mine operators have now found it necessary to fill the cave with waste rock that the Shattuck-Arizona Mining Company sent the specimens to the College of Mines. Superintendent Arthur Houle, of the Shattuck Company, is a brother of Professor A. J. Houle of the college.

UNIVERSITY AND EDUCATIONAL NEWS

THE Massachusetts committee on education voted unanimously on February 25 in favor of "taking initial steps toward the establishment of a state university."

ROBERT FLERSHEIM has left a bequest of a million marks to the University of Frankfurt.

DR. FRANK J. GOODNOW will be formally inaugurated president of the Johns Hopkins University on or about May 20. It is planned to give the occasion a double significance in inaugurating the third president of the university and formally dedicating the new site at Homewood.

AT Smith College the following promotions have been made: from assistant professor to associate professor, Inez Whipple Wilder, A.M., department of zoology; from instructor to assistant professor, Mary Murray Hopkins, A.M., department of astronomy, and Grace Neal Dolson, Ph.D., department of philosophy.

THE senate of the University of London has conferred, as we learn from *Nature*, the titles of professor and reader in the university upon the following: Dr. A. L. Bowley (London School of Economics), statistics; Mr. L. R. Dicksee (London School of Economics), accounting and business organization; Mr. J. E. S. Frazer (St. Mary's Hospital Medical School), anatomy; Dr. T. M. Lowry (Guy's

Hospital Medical School), chemistry; Mr. J. H. Morgan (University College and the London School of Economics), constitutional law; Dr. W. J. R. Simpson (King's College), hygiene and public health; Mr. J. H. Thomas (University College), sculpture; and Mr. G. Wallas (London School of Economics), political science.

DISCUSSION AND CORRESPONDENCE

HEADSHIP AND ORGANIZATION OF CLINICAL DEPARTMENTS OF FIRST-CLASS MEDICAL SCHOOLS

To the Editor of Science: In the October 30, 1914, number of Science there is a very interesting and timely article by Dr. Meltzer, of the Rockefeller Institute, on the reorganization of clinical teaching in this country, "Headship and Organization of Clinical Departments of First-class Medical Schools." The subject is a very important one and I feel sure that it will interest the many medical men who have the opportunity of reading your journal. Dr. Meltzer refers in his letter, which is written to a university president, to the report of the Council on Medical Education of the American Medical Association made to the House of Delegates of the A. M. A. in June of last year. He takes occasion to criticize in his letter several statements made in this report, and especially the statement "that the medical school very properly demands that its clinical teachers be men who are recognized as authorities in their special fields, both by the profession and the community," and he further objects to the use of the term "grotesque" as referred to a plan in which it is proposed that clinical teachers may do private practise, but that fees from such practise are to be turned into the university treasury. He also questions in advance the value of a report on the reorganization of clinical teaching that is to be made by a committee of the well-known clinical teachers to whom this subject has been referred by the Council on Medical Education.

As chairman of the Council on Medical Education I am very glad that this important subject is being discussed in the columns of such an influential journal as Science and by such an able physician and research worker as Dr. Meltzer. I feel, however, that the readers of Science and college presidents and trustees could not form an accurate view of the position taken by the American Medical Association from Dr. Meltzer's letter alone, and without reading the portion of the report of the Council on Medical Education referring to this subject, and therefore am enclosing this special part of our report from page 15 to page 17.

In the reorganization of our medical schools one of the most pressing needs is that of placing the clinical departments on a more satisfactory basis. Little has as yet been done in this country with this problem, and the time has arrived when the medical profession and the medical schools must take up this matter vigorously and formulate a general plan of organization of our clinical departments and urge its adoption. With this in view the Council on Medical Education has appointed a strong committee of ten clinicians, who have had great experience in teaching and who are regarded as authorities in their special departments and in medical education, to study this subject and report to the conference on medical education.

The organization of a clinical department is a more complex subject than that of a department like anatomy, or physiology, where teaching and research are the functions demanded.

In clinical work the head of the department and his associates must be three things; first, great physicians in their special field; second, trained teachers; and third, research workers. The medical school very properly demands that their clinical teachers be men who are recognized as authorities in their special fields, both by the profession and by the community. In the organization of a clinical department this fact must not be lost sight of and whatever plan is adopted must make it possible for the clinical teachers to remain the great authorities in their special fields both in the eyes of the profession and of the public.

The plan adopted by the German universities has been on the whole most satisfactory. There a professor in a clinical department is in every sense a university professor just as

much as the professor of chemistry or of physics. His university work commands his time. He must allow nothing to interfere with his teaching, his clinical work in the hospital or his research, and he devotes on the average quite as much time to his university work as does his colleague in chemistry or in mathematics. In addition to this, however, he devotes some time each day to private practise by which he maintains his position before the profession and the public as a great specialist. This can be done without neglecting his university position. In fact, if he does not remain the great physician, he ceases to be of as much value either to his students or to his university. On the other hand, if he should neglect his university work because of the time he devoted to private practise, his services would be dispensed with.

This problem of clinical teaching has been taken up during the year by the General Education Board and, as a result, an interesting experiment is to be tried at Johns Hopkins and possibly at one or two other places. The General Education Board has given Johns Hopkins $1,500,000 endowment with which to pay salaries to the departments of medicine, surgery and pediatrics. The position is taken in this experiment that the head of a clinical department should be given a very large salary and should receive no fees for private practise. It was recognized at once that the rich should not be deprived of the services of these experts, so the grotesque plan is proposed that these men may do private practise, but that fees from that practise are to be turned into the university treasury and not into their own pockets. [As will be seen by the context the word "grotesque" does not apply to the plan as a whole but is used to characterize that part of it which proposes that these clinical teachers may do private practise but are not permitted to receive any fees for these services, the understanding being that the fees are to be assessed and collected and appropriated by the university or hospital. I desire to assume the full responsibility for this particular portion of the report and to submit that the term "grotesque" is an exceedingly mild one to characterize such an unethical and illegal scheme. That the fees for the peculiarly individual and personal service rendered by a physician or surgeon to his patient should be appropriated by any institution and not go direct to the medical man rendering such service is clearly unethical. It is equally clear that it is illegal, as the institution would have no standing whatever in court if it sought to collect for itself the fees for such service. It is interesting to note in this connection that although these propositions are perfectly clear to men who are practising medicine, they are not as self-evident to non-clinical and non-medical men who are not in a position to understand the rights and interests of the medical profession.]

The men who proposed this plan, and provided the money necessary to make the experiment, are non-medical men; they do not have the medical point of view and they do not understand the complex functions demanded of the clinical teacher.

This plan has not been well received by the clinical teachers and finds its supporters almost entirely among the laboratory men. It is difficult to understand if the teachers in a medical school are to be placed on salaries and not permitted to receive any compensation for outside work, why the clinical teacher should be given a very large salary and his colleague in anatomy or in pathology a comparatively small one. The sweating of the scientific men who have devoted their lives to teaching and research on miserable salaries is notorious. Advantage has been taken of the fact that their scientific enthusiasm would hold them to their work and they are often as underpaid, comparatively, as the workers in a sweat shop. Surely, if the medical department of a university receives large endowments for the payment of salaries, the men teaching in the laboratory sciences should receive the first consideration. Again, if a clinical department obtained large sums for salaries, why should they pay a very large salary to the head of the department who in a very limited amount of time devoted to practise could obtain for his services much more than the amount of such

salary? Would it not be better to devote the available money to paying several younger men from 25 to 35 years of age—their more productive years—to devote practically all their time to teaching and research? Fortunately for the plan, the men who are responsible for it recognize that it is an experiment and frankly advise that it be not adopted by other medical colleges until it has been tried out on Hopkins.

The fact that such a plan has been seriously proposed by laymen interested in education emphasizes the necessity of a thorough reorganization of our scheme of clinical teaching along lines to be determined and agreed on by a committee of our best clinical teachers.

I should like to add the following comment.

First, that the Council of Medical Education believes that one of the most pressing needs is that of the reorganization of our clinical departments on a more satisfactory basis.

Second, the Council of Medical Education has taken the position that this important subject of the reorganization of clinical teaching should be submitted to a committee of experts, men who are recognized as great clinical teachers and who are familiar with the problems of clinical medicine. This committee is composed of the following men: Dr. V. C. Vaughan, University of Michigan, President of the American Medical Association; Dr. Geo. Armstrong, McGill University; Dr. John Finney, Johns Hopkins University; Dr. John Clark, University of Pennsylvania; Dr. W. J. Mayo, trustee of the University of Minnesota; Dr. Geo. deSchweinitz, University of Pennsylvania; Dr. Frank Billings, Rush Medical College, University of Chicago; Dr. Harvey Cushing, Harvard University; Dr. Geo. Dock, Washington University, and Dr. Saml. Lambert, Columbia University.

The committee is at present working on this problem. The Council on Medical Education does not know as yet what the findings of this committee will be. We believe, however, that the report of this committee will be of greater value than would the report on this particular subject of a committee of university presidents, professors in the science departments of universities, professors of the laboratory branches such as embryology, chemistry or physiology in a medical school, or men who are devoting their lives to the problems of medical research, but who are not in touch with clinical medicine. Would it not be well for university presidents, university trustees and medical faculties who contemplate reorganizing their clinical departments to await the findings of this committee representing the American Medical Association? The subject was discussed February 16, 1915, at the annual conference on medical education held in Chicago and the final report will be made to the house of delegates at the June meeting of the American Medical Association.

Arthur Dean Bevan

SOIL NITRATES

To the Editor of Science: In the reviews of an article[1] by Mr. Wright and myself appearing in a monthly bulletin of the International Institute of Agriculture[2] and the *Chemical Abstracts* of the American Chemical Society,[3] the point of view supported by our paper is not fully recognized. One review refers to the malnutrition of citrus trees as resulting from the toxic effects of superabundant nitrates, and the other refers especially to the production of malnutrition from the denitrification of soil nitrates. We presented the data of our experimental studies in California in some detail in order to draw attention to what we believe to be an important phenomenon, namely, that probably identical symptoms of malnutrition result either from superabundant nitrates which we regard as one phase of the so-called "alkali" poisoning and by nitrogen starvation which may re-

1 "Relation of Bacterial Transformations of Soil Nitrogen to Nutrition of Citrus Plants," Kellerman, K. F., and Wright, R. C. (Bureau of Plant Industry, U. S. Dept. of Agr.) in *Journal of Agricultural Research*, Vol. II., No. 2, p. 101–13, Washington, D. C., May, 1914.

2 *Monthly Bulletin of Agricultural Intelligence and Plant Diseases*, Year V., No. 9, p. 1166, September, 1914.

3 *Chemical Abstracts*, Vol. 8, No. 15, p. 2769, August 10, 1914.

sult either from a natural property of soil nitrogen or may be caused by denitrification of soil nitrates usually caused by improper cultural methods.

K. F. KELLERMAN

SCIENTIFIC BOOKS

Water Reptiles of the Past and Present. By SAMUEL WENDELL WILLISTON, professor of paleontology in the University of Chicago. University of Chicago Press, 1914. Pp. vii + 251, with 131 text-figures.

This interesting volume summarizes in a most authoritative manner our knowledge of the reptiles which have become adapted to aquatic life, and it also includes a chapter on the classification of reptiles, a subject upon which Professor Williston, with his forty years of special study, is abundantly fitted to speak.

In his introduction the author speaks earnestly in the defense of reptiles, which are so often of ill repute as cold, gliding, treacherous and venomous creatures shunning sunlight and always ready to poison. As a matter of fact, but few reptiles possess these evil propensities, for, aside from the venomous serpents, there are but two poisonous reptiles known, and the vast majority are not only innocent of all offense toward man, but are often useful to him. More than four thousand reptiles are living, representing, however, but four of the fifteen orders which were formerly alive. The terse definition of a reptile as a cold-blooded, backboned animal which breathes air throughout life is not surely correct, since it has been believed that certain extinct ones may have been warm-blooded.

While there are very marked distinctions of structure between the amphibians and the reptiles, there can be no doubt that the early amphibian ancestors of the modern toads, frogs and salamanders were also the ancestors of all living and extinct reptiles. This is proved by the fact that discoveries of recent years have bridged over nearly all the essential differences between the two classes so completely that many forms can not be classified unless one has their nearly complete skeletons. In the case of some of the oldest amphibia, the Stegocephalians, we know that they were water-breathers during part of their lives, because distinct impressions of their gills have been preserved, but we are not so sure that some of the more highly developed kinds were not air-breathers from the time they left the egg; if this be true, our definition of a reptile as distinct from an amphibian is rendered still less secure. We are quite certain that from some of the early extinct reptiles—probably the immediate forebears of the great dinosaurs—the class of birds arose, while another group of primitive reptiles, called the Theriodontia, and known chiefly from Africa, gave rise to the mammals.

The classification of reptiles is still a matter of much doubt and uncertainty, no two authors agreeing on the number of orders or the rank of many forms. Many strange and unclassifiable types which have come to light in North America, South Africa and Europe have thrown doubt on all previous classification schemes and have weakened our faith in all attempts to trace out the genealogies of the reptilian orders; and classification is merely genealogy. It is only the paleontologist who is competent to express opinions concerning the larger principles of classification of organisms and especially the classification of reptiles. The neozoologist, ignorant of extinct forms, can only hazard guesses and conjectures as to the relationships of the larger groups, for he has only the specialized or decadent remnants of past faunas upon which to base his opinions.

Williston's scheme of classification differs only in minor details from the more conservative of the generally accepted views, and those differences are, for the most part, the writer's own opinions, to be taken for what they are worth. It may be said decisively that no classification of the reptiles into major groups, into superfamilies or subclasses that has so far been proposed is worthy of acceptance; there is no such subclass as the Diapsida or Synapsida, for instance.

Williston recognizes and briefly diagnoses fifteen orders, of which three groups, the Proganosauria, Protorosauria and Thalattosauria, are provisionally given this rank.

The third chapter is an illuminating discussion of the skeleton of reptiles, in which the principal elements are not only fully described, but illustrated by the author's drawings.

The chapter on the Age of Reptiles contains a chart showing the range in time of the various reptilian suborders, beginning with the Carboniferous. Each important horizon is taken up in turn and the character of the sedimentation and location of the chief exposures discussed. This section is illustrated by Williston's restorations of various Permo-Carboniferous reptiles.

All this is by way of preparation for the main theme of the book—that of the adaptation of reptiles to aquatic life—and the fifth chapter discusses the problem in general, with the principal structural changes which water-living brings about, comparing the reptiles in their modification with other important aquatic types. Then in regular sequence the water-inhabiting orders are discussed: the Sauropterygia, *Lystriosaurus* among the Anomodontia, the Ichthyosauria in which the summit of aquatic adaptation is reached, *Mesosaurus* of the Proganosauria, *Pleurosaurus* of the Protorosauria, many of the Squamata, especially the marine iguana *Amblyrhynchus* of the Galapagos Islands, and the Agailosaurs and Mosasaurs, our knowledge of the last named being largely due to the author's own researches.

Another chapter treats of the Thalattosauria recently described by Dr. J. C. Merriam, while the Rhynchocephalia are represented by *Champsosaurus*. Crocodile-like forms are included under two orders, Parasuchia and Crocodilia, *Geosaurus,* an Upper Jurassic crocodile, going to the extreme and developing an ichthyosaur-like tail for swimming. The final chapter treats of the Chelonia, the most sharply distinguished order of reptiles and the one which had the most uniformly continuous and uneventful history from the Triassic to the present time.

This book is a thoughtful exposition of the entire subject from a master hand, and while necessarily technical in part, is written in such a style as to be eminently readable. It departs from the great majority of popular books of "ancient monsters" because it is written by one who has a world-wide reputation as an authority on the subject of which he treats.

In view of the success of the present volume and of the preceding *"American Permian Vertebrates,"* Williston's announced volume on the evolution of the reptiles is anxiously awaited.

RICHARD S. LULL

YALE UNIVERSITY,
February 1, 1915

Festschrift Max Bauer zum siebzigsten Geburtstag gewidmet. Edited by R. BRAUNS. Stuttgart, E. Schweizerbartsche Verlagsbuchhandlung, 1914. Pp. viii + 568, portrait, 32 plates and 47 text-figures; Neues Jahrbuch für Mineralogie, Geologie und Paläontologie, Beilage Band XXXIX.

As a richly deserved and most fitting tribute of regard and esteem to a scientist of distinguished merit, the recent issue of a supplementary volume of the "Neues Jahrbuch für Mineralogie, Geologie und Paläontologie," in honor of the seventieth anniversary of the birth of Herrn Geheimrath Professor Dr. Max Bauer, founder of the Mineralogical Institute of the University of Marburg, enlists the sympathies of all interested in scientific progress, more especially in the domain of mineralogy. This handsome octavo volume extends to nearly 600 pages, and is embellished with an excellent likeness of Professor Bauer, as well as with 32 well-executed plates and 47 text-figures illustrating the subject-matter of the various articles. The dedication from his friends, coworkers and students gives warm expression to their appreciation of his services in the cause of science.

Of the many valuable papers in this testimonial "Festschrift" we can do little more than cite the titles or indicate the subject-matter. Professor Alfred Bergeot, of Königsberg, treats of the structure of the manganese deposits at Meggen-an-der-Lenne, and emphasizes their value in a determination of the geological formation of this region (pp. 1–63);

Dr. R. Brauns studies the scapolite-bearing eruptive rocks in the lake region of Laach (pp. 79–125). A full and interesting paper on the discovery of a small crystal-grotto in pegmatitic granite of Wildenau, Saxon Vogtland (pp. 126–185, 5 plates and 4 figs.), is contributed by Dr. Ross Bruno. A study, with analyses of the basalts of Marburg, is offered by Professor Arthur Schwantke (pp. 531–567, 8 plates and 5 figs.), and one on the origin of talc deposits by Professor C. Doelter of Vienna (pp. 521–530). Much interesting information as to the nephrite of Harzburg is supplied by Dr. J. Uhlig, of Bonn.

There is also a paper on the monazite of Dattas, Diamantina, State of Minas Geraes, Brazil, by Dr. K. Busz (pp. 482–499); the methods employed for investigating the molecular structure of silicate solutions are treated of by Dr. H. E. Boeke (pp. 64–78) and a brief account of a polishing apparatus for crystal planes is given by Dr. Victor Goldschmidt, of Heidelberg (pp. 186–192). This is followed by a paper on an instance of the deposition of sodium in contact-metamorphosis at Langesundsfjord, Norway, by V. M. Goldschmidt, of Kristiania (pp. 193–224), and a study of certain aspects of monohydrate lithium-sulphates, by Dr. A. Johnsen (pp. 500–520). The elæolite-syenite-laccolite of the Sierra de Monachique in southern Portugal is the subject chosen by Dr. Erich Keiser, of Giessen (pp. 225–267, with geological sketch map on Plate XII); Dr. Eduard Raphael Liesegang treats of pseudoclase (pp. 268–276); the nomenclature of crystal forms is studied by Dr. L. Milch (pp. 277–289), and a paper on the granites of the Carpathians is contributed by Dr. J. Morozewicz (pp. 290–345).

In his account of the tin deposits of Tasmania (pp. 346–387) Dr. Fritz Noething expresses the opinion that these deposits are either entirely or in great part of marine, not of fluviatile origin. This paper is followed by one on colloidal silicates by Dr. F. Rinne (pp. 388–414). Besides his study of the nephrite of Harzburg, Dr. J. Uhlig reports on a diopside with manganese from the same region (pp. 446–449). Less strictly scientific, but extremely interesting as a contribution to the historic description of a celebrated volcano, is the paper by Dr. K. Sapper on the "Hell of Masaya," presenting a synopsis of the accounts of this Nicaraguan volcano given by the early Spanish visitors to this region, several of whom ascended to the mouth of the crater, beginning with the ascent made in 1529 by Gonzalo Fernandez de Oviedo y Valdés.

The mere recital of the many subjects treated of in this volume is a sufficient indication of its wide range and of the variety and value of its contents, rendering it an important contribution to mineralogical science.

The birthplace of Professor Bauer was the village of Gnadenthal, near Schwabisch-Hall, in Wurtemberg; at the date of his birth, September 13, 1844, his father was the pastor of the community. Two years later, Pastor Bauer was transferred to Aalau and then to Kunzelsau and Weinberg; in this last-named place he was acting as "superintendent" at the time of his death in 1872.[1]

Max Hermann Bauer was the eldest of eight children, six of whom still survive. In 1859, when fifteen years old, he entered the Polytechnic school in Stuttgart, where he devoted himself to the study of mining engineering and metallurgy, his interest in this latter branch having been awakened by frequent visits to the large iron foundries and mines of Wasseralfingen quite near Aalau, with whose officials his parents were well acquainted. However, the question soon arose whether this field would offer sufficient guarantees for the future in the case of one without private fortune. Of the extremely conservative ideas prevailing in his immediate neighborhood Dr. Bauer writes: "In my native place at that time people usually felt themselves confined to the narrow limits of their birthplace; the idea of seeking elsewhere the more favorable opportunities lacking there, was regarded as eccentric."

Hence the young student, after successfully passing his examination in the Stuttgart Polytechnicum in 1862, turned his attention more especially to mathematics and the natural sciences, which he pursued from 1863 to 1865 at

[1] These autobiographical details were very kindly furnished to me by Professor Bauer.

the University of Tübingen, with the intention of qualifying himself for instruction. When this course was completed, he became an instructor, successively, in several Realschulen in Wurtemberg. His services in this capacity were so highly appreciated that the government sent him to Paris in 1867 to perfect himself in the French language.

However, his growing interest in mineralogy and geology gradually induced him to devote more and more of his time to these studies, and the doctor's degree was awarded him by Tübingen University for a dissertation entitled: "Die Braunsteingänge von Neuenberg." Another period of study in Tübingen in 1868 enabled him to profit by the instruction of Professor Eduard Reusch, an authority on crystallography, and for a time Dr. Bauer confined himself essentially to this science, while not neglecting geology and paleontology. Some of the results of his crystallographic investigations were presented in his first treatise, on mica, issued in 1869, while a number of articles on geology and paleontology as well as his participation for a score of years in the preparation of the special geological map of Prussia, on a scale of 1:25,000, showed his proficiency in these sciences.

The autumn of 1868 found Dr. Bauer in Berlin pursuing a course of study in the mineralogical institute there under the direction of Gustav Rose. The outbreak of the Franco-Prussian War in July, 1870, interrupted these studies, as Dr. Bauer volunteered in defence of his Fatherland. After the termination of this war he was active for a time in Munich and then again in Tübingen, proceeding thence to Göttingen, where he became privat docent of mineralogy and geology. In 1872 he occupied a similar position in Berlin University, also becoming first assistant in the mineralogical institute. From Berlin, in 1875, he was called to the University of Königsberg as ordinary professor of mineralogy and geology. These studies had for a time been somewhat neglected in this university, and there was a sad lack of instruments, books and specimens; not a single fossil was to be seen. This condition of things was entirely changed by Professor Bauer during the one and a half years of his stay. While his lectures embraced the entire field of mineralogy, geology and paleontology, his own personal studies were especially concerned with crystallography and crystallographico-physical investigations. It was toward the close of this residence in Königsberg that he issued his "Lehrbuch der Mineralogie" (1st ed., 1886; 2d ed., 1904).

In the autumn of 1884 Professor Bauer transferred his activities to the University of Marburg, where he has been professor of mineralogy and petrography for the past thirty years. During this period he has devoted special attention to the diabases of Hesse and Nassau and to the basaltic region of Hesse, formations which theretofore had been little studied.

At the time of Professor Bauer's removal to Marburg, he succeeded to C. Klein as editor of the mineralogical section of the *Neues Jahrbuch für Mineralogie, Geologie und Paläontologie* and has carried on this task up to the present time. During this long period more than fifty regular volumes of the *Jahrbuch* and thirty-eight supplementary volumes have been issued, and also more than a dozen volumes of the *Centralblatt für Mineralogie, Geologie und Paläontologie,* a publication connected with the *Jahrbuch,* so that the editorial supervision of Professor Bauer has covered some one hundred volumes of these journals.

The valuable researches and publications of Professor Bauer on precious stones also belong to this period, visits to the famous gem-cutting establishments of Idar-Oberstein and to the diamond-cutters of Hanau having aroused his interest in this direction. A more definite direction to his activity was, however, provided by the plan of a German publishing house to bring out a translation of the present writer's "Gems and Precious Stones of North America." The task of translating and adapting this book was entrusted to Professor Bauer. As the publishers wished to enlarge the scope of the work while retaining its rich embellishment of colored plates, the enterprise resulted in the production of the "Edelsteinkunde" (1st ed., 1896; 2d ed., 1909), an English version of which was published by Dr. L. F.

Spencer, director of the mineralogical department of the British Museum, in 1904.

GEORGE F. KUNZ

Optic Projection. Principles, Installation and Use of the Magic Lantern, Projection Microscope, Reflecting Lantern and Moving Picture Machine. By SIMON HENRY GAGE and HENRY PHELPS GAGE. The Comstock Press, Ithaca. 1914. Pp. 731. $3.00.

Professor Gage and his son, Dr. Gage, have written a timely and compendious treatment of optical projection that will be heartily welcomed by all who are interested in the subject. Such recent developments of the art of projection as cinematography and opaque projection are discussed at length, while the older ordinary forms of projection are not neglected.

The titles of the fifteen chapters are, in order: Magic Lantern with Direct Circuit; Magic Lantern with Alternating Current; Magic Lantern for Use on the House Electric Lighting System; Magic Lantern with the Lime Light; Magic Lantern with Petroleum Lamp, with Gas, Acetylene and Alcohol Lamps; Magic Lantern with Sunlight, Heliostats; Projection of Images of Opaque Objects; Preparation of Lantern Slides; The Projection Microscope; Drawing and Photography with Projection Apparatus; Moving Pictures; Projection Rooms and Screens; Electric Currents and their Measurement, Arc Lamps, Wiring and Control, Candle Power of Arc Lamps for Projection; Optics of Projection; Uses of Projection in Physics, Normal and Defective Vision. In addition there is given a historical outline of the origin and development of projection apparatus, a list of manufacturers of and dealers in projection apparatus, a bibliography and an index of both names and subjects. There are 413 cuts and diagrams.

The authors state that their aim has been to explain the underlying principles upon which the art of projection depends and to give such simple and explicit directions that any intelligent person can succeed in all the fields of projection. The point of view throughout is that of the skilled amateur. To the professional operator the treatment will appear academic, to the theorist it will appear very practical, but all will agree that it covers the middle ground clearly and exhaustively.

P. G. NUTTING

THE METEROLOGY OF ADELIE LAND, ANTARCTICA

THE climatic facts set forth by Sir Douglas Mawson in his interesting volumes, "The Home of the Blizzard," reviewed last week in SCIENCE, justify his claim that it is the stormiest spot on the face of the earth. Although the data as to the weather are desultory and incomplete, except as to the winds, yet a brief survey of this newly discovered land is of scientific interest. Fortunately the expedition was equipped with recording instruments for barometer, sunshine, temperature, wind, etc., so that data exist for full and satisfactory discussion of local meteorology in the promised scientific volumes. Observations were made at the main base, Commonwealth Bay, 67° S., 133° E., and by the sledging parties through King George Land.

No table of monthly means of any kind are given, but it is stated that the mean temperature for the first year was slightly above zero. This is an exceedingly low temperature for the latitude, 67° S. It is, however, not a local cold of radiation, but a cold of translation through the continuous and violent downflow of air from the elevated plateaus of Antarctica, 11,000 feet or more above sea level. The sharp pitch of the land is shown by the rise of 1,900 feet in fourteen and a half miles from the sea. The temperatures were never exceeding low, but were steadily maintained. The minimum temperature at the seacoast was only —28°, and the lowest observed on the ice-cap of the hinterland during the spring sledging was —35°; on September 18, 1912.

From a shaft excavated in the nevé of the hinterland, at an elevation of 2,900 feet, Bage calculated that the mean temperature of the snow, which would be higher than the air, for the year was approximately —16°. It would not be unreasonable from these data to place the mean annual temperature of the south-polar plateau at —40°. The contrast between temperatures during high winds and in pe-

riods of comparative calm are noticeable. On November 19, during good weather, at an elevation of 2,600 feet the temperature fluctuated between zero and 18°, but five days later with a wind of 40 miles per hour it sank to —10°. On December 18, at 5,500 feet, the temperature rose with fine weather twenty-four degrees in a day, while the black bulb registered 105° in the sun.

Wild's station, Queen Mary Land, 66° 30′ S., 95° E., about 1,200 miles to the westward of Mawson's on Adelie Land, appears from the few data available to be somewhat warmer, although the extremes were greater, a mimimum of —38° being reported on December 21, 1912. The monthly mean temperature for June, 1912, was —14.5°, and for July —1.5°, while the means for the German expedition, under Drygalski, about 150 miles to the westward, in 66° 2′ S., 89° 38′ E., in 1902 were 0.5° for June, —0.6° for July, and for a year 11.3°. From these comparative data the annual mean at Wild's station, Queen Mary Land, would be about 8°. Field observations on the glacier-covered hinterland show a minimum of —47°, and a reading of 87° on December 21, from a thermometer laid on an area of black rock. These data probably give an approximation to the annual mean temperature of slightly above zero, Fahrenheit, along the antarctic circle for say 2,000 miles, between 86° and 150° E. longitude.

Bearing on the intimate local relations between the winds and the temperatures of Adelie Land, Mawson says:

> The stronger the wind blew, the less variation did the thermometer show. Over a period of several days there might be a range of only four or five degrees. . . . The compression of the atmosphere during the gusts affected the air temperature so considerably that, coincident with their passages, the mercury column would be seen rising and falling through several degrees.

The only statement available as to the barometer reading runs:

> On July 11, 1913, there was an exceptionally low barometer at 27.794 inches. At the same time the wind ran riot once more—298 miles in three hours. The barometric curve, remarkably even, did not show as much range as one twentieth of an inch. The highest barometric reading was on September 3, 30.4 inches, and the comparison indicates a wide range for a station at sea-level. . . .

Annual barometric means in other portions of the Antarctic regions are as follows: *Discovery,* 77° 51′ S., 167° E., 1902–04, 29.29 inches; Cape Adare, Victoria Land, 2 months only, 29.134; *Belgica,* 70° 30′ S., 88° 30′ W., 1902–03, 29.307; *Gauss,* 66° 2′ S., 89° 38′ E., 1902–03, 29.134. The data of Mawson's expedition will have a bearing on the theory quite steadily advanced, but which the writer has been inclined to question, of a marked anticyclonic area over the vicinity of the South Pole.

The extreme violence of the winds, and the general prevalence of drifting snow have made it impossible to measure with any degree of definiteness the snowfall of Adelie Land. Heavy falls of snow occurred, one being mentioned as amounting in a day to two feet. Of the effect of the wind on the snow Mawson says:

> First, under the flail of the incessant wind, a crust would form, never strong enough to bear a man. Next day the crust would be etched, and small flakes and pellets would be carried away. Long shallow concavities would now be scooped out; these became deeper hour by hour, becoming at last the troughs between the crests of the snow-waves or sastrugi.

The abrasive effects of the drifting snow were astonishing. He adds:

> The southern, windward faces of exposed rocks were on the whole smooth and rounded; the leeward faces were rougher and more disintegrated. On the windward side the harder portions of the non-homogeneous rocks were raised in relief.

Of quantities he says:

> Day by day deluges of drift streamed by the Hut, at times so dense as to obscure objects three feet away, until it seemed as if the atmosphere were almost solid snow.

Mawson adds:

> A point which struck me was the enormous amount of cold communicated to the sea by billions of tons of low-temperature snow thrown upon

its surface, the water already at the freezing point.

The most remarkable feature of the climatic conditions of Adelie Land are the violence and constancy of the winds. They are hurricane in force and, from the data in these volumes, appear to have come invariably from the south-south-east. Their regularity was most remarkable, and the direction so constant that field parties traveled during blizzards and in semi-darkness by shaping their course relative to the wind. Indeed the wind—and the sastrugi formed by it—was a far better direction-guide than was the compass, affected by their proximity to the magnetic pole. The average hourly velocity of the wind for the first year—determined by a registering Robinson anemometer, was fifty miles. The average for March, 1912, was 49; April, 51.5, and May, 60.7 miles. Hourly velocities of 90 miles were not uncommon, and in a number of cases the rate exceeded 100 miles. The most remarkable winds—which from the snow carried by them assumed the character of blizzards—are as follows: 1912 (for the 24 hours), May 11, 80 miles; May 15, 90; May 22 (gust approximating 200 miles per hour, with temperature of —28°); 1913, May, 17 (24 hours), 83 miles; May 18, 93.7 (between 6 and 7 P.M. of the 18th the instrument recorded 103 miles); July 5, 116 miles in one hour, and an average of 107 miles for eight consecutive hours; July 11, 298 miles in three hours; August 16, 105 miles in an hour. Gusts were determined from time to time by an instrument called a puffometer, by which winds in gust were noted of an extreme velocity of about 220 miles, though necessarily such record could not be considered as absolutely accurate.

Meteorologists have usually associated whirlwinds with heated or desert regions. Mawson related:

> Whirlwinds of a few yards to a hundred yards or more in diameter which were peculiar to the country. The velocity of the wind in the rotating column being very great, a corresponding lifting power was imparted to it. The lid of a case, weighing more than 300 pounds, was whisked into the air and dropped fifty yards away. An hour afterwards the lid was picked up again, and struck against the rocks with such force that part of it was shivered to pieces.

Regions of calms sometimes obtained in a sheltered locality immediately under hurricane winds. One man working in a fifty mile gale at the Hut, on the upper cliffs, walked down to the harbor ice and suddenly found himself in an area of calm. As compared with the force of winds of the *Discovery*, 77° 51′ S., 167° E., 10.3 miles per hour, the winds of Adelie Land are nearly six times as violent. As to direction the *Discovery* winds as determined from the lower clouds showed 18 per cent. S., 15 S.W. and 15 S.E. At Cape Adare, with 10 per cent. calms, there were 20.4 per cent. winds from the S.E. and 13.9 from the S. These data seem to bring the S.S.E. winds of Adelie Land in harmony with those a few hundred miles to the southeast. The *Gauss*, 66° S., 90° E., was frozen-in a long distance from land so that its winds, 47.8 per cent. from the E., are not directly comparable with those 1,700 to 2,000 miles to the eastward.

It is evident that Mawson is justified in calling Adelie Land the *Home of the Blizzard*, and in claiming that it is the windiest region on the earth at the level of the sea. Meteorologists will look forward with interest to the publication of the full observations with their scientific discussion.

A. W. GREELY

REPORT OF THE COMMITTEE OF THE AMERICAN ASSOCIATION OF ANATOMISTS ON PREMEDICAL WORK IN BIOLOGY

AT the meeting of the American Association of Anatomists in Philadelphia, December, 1913, a committee was named by the president of the association to confer with the zoologists on the subject of work in biology preliminary to the study of medicine.

In accordance with the original motion of the chairman, which led to the appointment of this committee, the following report was submitted to the association December 29, 1914, at the St. Louis meeting:

Your committee was appointed to confer with the zoologists to ascertain what coopera-

tion may be expected toward standardizing work in biology required of students looking forward to the study of medicine; and to formulate the considerations which would seem practical to incorporate in plans for such courses.

The Zoological Society promptly appointed a committee for this conference, and the following questions were discussed, not only with this committee, but with a number of representative members of the Zoological Society. Besides this, published statements of courses and of discussions on this subject were examined.

The following questions seemed to be most important.

Question 1. Is the work given in different colleges in the elementary, general course in biology adapted to satisfy the requirements of premedical training in this subject?

Question 2. Is it possible to so select and standardize the work of the first year in biology in different colleges as to make it uniform, and to include, here, all needed to make it an adequate course?

Question 3. If an ideal course, including sufficient preliminary work, can not be secured within the one-year period advocated, what principles should be urged to govern the planning of the biological work of students looking forward to the study of medicine, so that they will profit most by the training of the first year, and be best prepared to follow this up in special departments of biology more directly related to medicine.

Question 4. What additional work is to be advised, which is not to be obtained in the first year's general course?

Both committees agree that it is of the first importance to urge the selection of only thoroughly trained scientific men as teachers for this work. Such men can be trusted to insist on real scientific methods and to select the best material and treatment to give the beginner a practical introduction and basis for further work.

Beyond this point, however, the committees were unable to proceed. The zoologists suggested that the anatomists should draw up a statement of what they desire the zoologists to do, in preparing students for anatomy. After this has been done, the zoologists are ready to consider how far it is practicable to meet these needs. Several attempts have been made in this direction, and your committee submits the following statement to the association for its approval, and transmission to the zoologists.

At the present time a one-year's course in biology is generally required as a preparation for the work of the medical school. This study of biology must serve as a preparation for medical work in physiology, pathology, bacteriology and parasitology, as well as anatomy, and it may fairly be questioned whether a single college course is adequate for this purpose. The study of botany alone is obviously insufficient, and the domain of zoology is so vast that much care should be exercised in the choice of those phases of the science to be presented to young students. Courses which are primarily experimental and deal with the functions and reactions of animals, although excellent in preparation for the physiological work of the medical school, are not the proper basis for the study of human anatomy. It is the purpose of this report to point out only those features of the college preparation which experience has shown to be desirable, and in fact essential, for the successful study of gross and microscopic anatomy.

No uniform or stereotyped preparatory course is recommended, for it is recognized that every teacher should give special attention to those subjects and groups in which he is particularly interested, and to the knowledge of which he has contributed by his own researches. Success depends in large part upon the ability of the teacher, but the following purposes of instruction should not be forgotten if the preparatory work is to satisfy the requirements of anatomy.

1. Students frequently begin the study of human anatomy with an insufficient knowledge of the lower forms of animal life. The broad knowledge of the various classes of animals and of invertebrate and lower-vertebrate morphology, which was the inspiration of the

great anatomists of the past, is now too often replaced by vague considerations of the method of science and ideals of observation. A return to the study of animals, as objects of interest in themselves, apart from theoretical considerations and possible relations to human society, is therefore recommended. The student should obtain a synoptic knowledge of the animal kingdom, and should be able to classify, in a general way, and to describe the life histories of the common forms of animals, aquatic and terrestrial, which may be collected in his locality. A beginning in such work may well be made by the student independently or perhaps in high-school courses, but such fragmentary and elementary studies should be supplemented by a thorough college course. The first-hand familiarity with animals should serve as the basis for all further work.

2. As a result of the knowledge of genera and species which the student should have obtained directly for himself by studying some group of animals or plants, questions of the origin of species and of the relation of the great classes of animals to one another are inevitably before him as philosophical problems. Collateral reading then becomes as necessary for the biologist as for the man of learning in any other branch of knowledge. Selected works of Lamarck, Darwin, Huxley, Mendel and others should be freely consulted. This literature, which in its influence upon human thought has far outspread the bounds of biology, should not be neglected by the student of zoology, whose particular heritage it is. Since the idea that science can not be read, and that there is no knowledge in books, is often taught as a cardinal principle, it has come about that students of zoology have little knowledge of, or respect for, the writings of the makers of their science.

3. Before beginning the study of human histology, every student may reasonably be expected to be familiar with the use of the microscope and with the simpler methods of preparing specimens for microscopic examination. This technique can be learned in connection with various courses, perhaps the most useful of which is a general study of the cell with a comparative study of the elementary tissues. The maturation of the germ cells and the processes of fertilization and segmentation can not be properly presented in the medical curriculum, and these fundamental biological phenomena should therefore be observed in college courses. The development of the chick, which was studied primarily by physicians to explain the growth of the human embryo, can likewise receive little attention in the medical school. These subjects are all very desirable in themselves, and if studied by laboratory methods, will supply the requisite skill in the use of the microscope.

4. In preparing for human dissection, comparative anatomy should be studied with the same standards of thoroughness which obtain in the dissecting room. The student should learn to dissect rapidly and well, and to record with careful drawings and brief descriptions the forms and relations of the structures which he has disclosed. But such studies are not useful merely for their methods. A knowledge of comparative anatomy, including especially the anatomy of the lower vertebrates, is indispensable for understanding the structure of the human body. For other reasons also, human anatomy must be treated as an advanced study. The state does not provide bodies for dissection in order that untrained students may learn from them those elementary facts, which may be understood equally well by dissecting cats or rabbits. "It is absurd," says President Eliot, "to begin with the human body the practise of dissection." And the value of dissection is so great in relation to both medicine and surgery, that an adequate preparation should be required. For the study of anatomy, in the words of Lord Macauley, "is not a mere question of science; it is not the unprofitable exercise of an ingenious mind; it is a question between health and sickness, between ease and torment, between life and death."

5. Finally, these recommendations may be summarized as a plea for a more thorough study of zoology on the part of those planning

to enter the medical schools. The zoological courses should not be abridged and popularized in order that time may be saved for other pursuits, or that the science may seem more attractive to college youth. Courses in anatomy and physiology which duplicate the work of the medical school, and courses in "medical zoology," ought not to be substituted for the strictly zoological university courses. The science of zoology is of such great service to students of medicine that it deserves a large place in their undergraduate studies. With medical anatomy, it constitutes "a subject essentially one and indivisible"; and the penalty for its neglect is inadequate preparation for medical practise.

Committee: H. McE. Knower, *Chairman,*
F. T. Lewis,
W. H. Lewis

St. Louis, Missouri,
December 29, 1914

In the following summary, the chairman of the committee has rearranged the main points of the above report in groups, to correspond to the four questions proposed at the beginning; so that a more definite idea may be secured of the manner in which these are answered. In assembling the answers to the different questions the exact sense of the report itself has been retained. In answering questions 3 and 4 an effort has been made to indicate what we may reasonably expect to include in the first year, and what should be advised in addition.

I and II. The first two questions formulated by the committee are answered in the negative; that is, a one-year's course is not regarded as sufficient, and a uniform, standardized course seems undesirable. An introduction to the subject through special courses in selected "medical zoology" is also disapproved.

III. (*a*) In regard to the third question; it has seemed necessary to urge a more thorough knowledge of the morphology of lower forms of animals and their life histories. While the anatomists in adopting this statement as given in the report, undoubtedly expect the physiological aspects of these mechanisms to be considered as necessary accompaniments of such first-hand familiarity with animals, it is urged in the report that the introductory college course shall not be "primarily physiological." It is earnestly desired that the work shall involve a rigorous grounding in comparative morphology, especially of lower forms, which furnishes not only the best basis for human anatomy, but is a very essential preliminary for comparative and human physiology.

(*b*) It is urged that the theoretical and philosophical considerations which accompany the course shall follow a practical acquaintance with animals, rather than that special animal structures shall serve chiefly as illustrative material for lectures on general biological theories, with a neglect of a thorough study of a series of animal forms.

(*c*) The additional principles which should govern the planning of the introductory courses, beyond those just stated, are:

The selection of suitable teachers.

The undesirability of attempting to establish a uniform preparatory course, or courses especially limited to applications to medicine.

The acquirement of skill in the use of the microscope, and of correct scientific method of work in connection with the work of the course.

The beginnings of embryology and cytology.

IV. As to the last question, number 4, the report does not attempt to decide what proportion of the recommended preparation for anatomy can be obtained by a student in the first year's course. This must be indicated by the zoologists. It seems evident to a student of present conditions, however, that most of the work desired in cytology and comparative, general histology; comparative anatomy of vertebrates; or systematic zoology will have to be elected by students looking forward to medicine, after they have taken the introductory course. It is to be hoped that the elements of vertebrate embryology will be included in that course. Some of this work may well be done in one of the excellent summer laboratories.

V. Finally, the importance of collateral reading in the masterpieces of biological literature is strongly emphasized.

At the St. Louis meeting of the American Association of Anatomists, December 29, 1914, the report of the committee on premedical work in biology was approved by the association; and the committee was continued with instructions to submit the approved report to the zoologists, and to secure their cooperation in carrying the work further.

H. McE. KNOWER, *Chairman*

SPECIAL ARTICLES

SEX DETERMINATION AND SEX CONTROL IN GUINEA-PIGS

THE observations, a short exposition of which is given here, were made on guinea-pigs, being used by Professor Stockard in heredity experiments. He very kindly placed the material at my disposal for this study, and I wish to express my appreciation of this favor.

These observations show that the sex of a guinea-pig is determined sometimes by two and sometimes by three factors, depending upon whether the mother has previously born young.

The first factor "A" is the sex tendency of the father. If the father has a male sex tendency, his sons will have a female tendency and his daughters a male tendency. If, on the contrary, the father possesses a female tendency, his sons will have male tendencies and his daughters female tendencies. In other words, sons exhibit the opposite and the daughters the same tendency as the father.

The second factor "B" is the sex tendency of the mother. A mother with a male tendency gives her daughters a female and her sons a male tendency. The mother with a female tendency gives her daughters a male and her sons a female tendency. Thus the transmission of the sex tendency from the female is also criss-cross in the same fashion as that of the male. The females inherit like tendencies from their father and the males like tendencies from their mother, whereas the males inherit the reverse tendency of their father and the females the reverse tendency of their mother.

The third factor "C" is confined to the female and is a change of sex tendency from litter to litter. This change in tendency manifests itself in the following way:

If the first litter contains only males, the mother acquires a female tendency for the next litter and vice-versa. This new tendency varies in strength, depending upon the number of young of one sex contained in a litter. The greater the number of males in a litter, the stronger the female tendency will be for the next litter. This tendency is still more emphasized if the mother is successively mated with males of a definite tendency, and therefore forced to produce more and more young of one sex.

The tendency of the various animals of a certain stock must first be ascertained in an experimental manner; given a number of undetermined males and females, each male must be mated with all the females and each female with all the males. After all the animals have been tested in this way, the results will show more males from some animals and more females from others. If, now, the offspring from these matings be grouped so as to take those animals which have come from more male producing fathers and their tendency be tested, it will be found that from the males more females will be produced and from the females more males. Provided the determination of the sex tendency for the first set of animals was absolutely correct, and if there was no other factor in action, the proportion of males to females should be as 75:25 from male producing males mated with females having different tendencies, and from female producing males the proportion is reversed. It is, however, very difficult to determine absolutely the sex tendency of an animal after only a few matings, and for this reason, some animals supposed to have a male tendency will probably have a weak female tendency, and *vice versa.*

In order to find with reasonable definiteness

the tendency of animals, the tendency of the ancestors for three or more generations should be known. It must also be recalled, as explained above, that the third factor "C" in the female reduces the difference between the ratio numbers of her male and female descendants. As a result of this, the difference between the number of males and females considering only mother tendency is smaller than the difference between males and females in the light of only the father tendency. A male has a male tendency or a female tendency and always maintains it, whereas the female has a born male or female tendency, but in addition to this she has a second tendency to change her sex tendency from litter to litter. The number of males and females derived from the second generation was as follows:

I. Descendants of males whose fathers had a male tendency mated with mixed females; 39 males to 54 females, *i. e.*, 41.94 per cent. males to 58.06 per cent. females (sex ratio 72.20).

II. Descendants of males whose fathers had a female tendency mated with mixed females; 42 males to 23 females, *i. e.*, 64.61 per cent. males to 35.39 per cent. females (sex ratio 182.60).

III. Descendants of males whose mothers had a male tendency mated with mixed females; 64 males to 53 females, *i. e.*, 54.70 per cent. males to 45.30 per cent. females (sex ratio 120.83).

IV. Descendants of males whose mothers had a female tendency mated with mixed females; 12 males to 13 females, *i. e.*, 48 per cent. males to 52 per cent. females (sex ratio 92.30).

V. Descendants of females whose mothers had a male tendency mated with mixed males; 13 males to 18 females, *i. e.*, 41.94 per cent. males to 58.06 per cent. females (sex ratio 72.22).

VI. Descendants of females whose mothers had a female tendency mated with mixed males; 51 males to 43 females, *i. e.*, 54.25 per cent. males to 45.75 per cent. females (sex ratio 118.60).

VII. Descendants of females whose fathers had a male tendency mated with mixed males; 38 males to 36 females, *i. e.*, 51.38 per cent. males to 48.62 per cent. females (sex ratio 105.55).

VIII. Descendants of females whose fathers had a female tendency mated with mixed males; 33 males to 37 females, *i. e.*, 47.15 per cent. males to 52.85 per cent. females (sex ratio 89.18).

These figures show that in the sons the tendency received from the father is stronger than that coming from the mother, while in the daughters the opposite is true.

When one examines the descendants of animals whose fathers had a male tendency and mothers a female tendency, a higher difference in the relative number of males and females is found than from those cases in which the fathers alone had a male tendency. Twenty descendants of such male animals (father male tendency and mother female tendency) mated with mixed females consisted of four males and sixteen females, *i. e.*, 20 per cent. males and 80 per cent. females (sex ratio 25.00). From the females of the same type (father male tendency and mother female tendency) mated with mixed males, 29 males and 15 females were derived, *i. e.*, 65.90 per cent. males to 34.10 per cent. females (sex ratio 193.33).

From the second-generation males whose fathers had a female tendency and whose mothers show a male tendency when mated with mixed females were derived 32 males and 15 females, *i. e.*, 68.08 per cent. males to 31.92 per cent. females (sex ratio 213.33). From the females of the same type (father female tendency and mother male tendency) mated with mixed males were derived 6 males and 13 female descendants, *i. e.*, 31.58 per cent. males to 68.42 per cent. females (sex ratio 46.15).

Should one select males whose fathers had a female tendency and whose mothers had a male tendency and mate these with females whose fathers had a male tendency and whose mothers had a female tendency, a higher difference in the relative number of males and

females will be found in their descendants than in any other possible case. From such combinations were derived nine animals, all males. In the same way, from the combination a male derived from a father, male tendency, and mother, female tendency, mated with a female from father, female tendency and mother male tendency, were derived six animals all of which were females.

This regulation in the inheritance of the sex tendency is especially interesting in affording an explanation of the manner in which the equilibrium is maintained between the number of male and female offspring of a given species. With each new generation each male animal has an opposite tendency from that of his father and each female animal an opposite tendency from that of her mother. It, therefore, follows that a disturbance of the equilibrium in one generation will tend to be restored by the opposite tendencies in the following generation. The above-mentioned change of sex tendency from litter to litter in the female leads to the same result. This third factor "C" regulates equilibrium from birth to birth so that any disturbance of a great degree is impossible.

The difference in the proportion between the sexes in different species may be due to the fact that in some species the father and mother have an equal influence on the determination of the sex of their offspring while in other species either the father or the mother may have the greater influence.

When father and mother have equal influence, the combination father, male tendency, with mother, female tendency, will give equal number males with females tendencies and females with male tendency, and the combination father, female tendency, with mother, male tendency, will give equal number males with male tendency and females with female tendency. In this way equal numbers of male and female descendants will be produced and equal numbers of the descendants will have male and female tendencies. In such a case the sex ratio should be 100 per cent. Should, on the other hand, the mother have the greater influence on the determination of sex, as seems to be the case in the guinea-pigs, then the number of descendants with a male tendency will be greater than the number of those having a female tendency, as the following scheme shows:

Father with male tendency mated with mother with female tendency will give more females (male tendency) than males (female tendency).

Father with a female tendency mated with a mother with a male tendency gives more males (male tendency) than females (female tendency). Therefore from either combination the greater number of offspring have a male tendency and as a result of this the sex ratio will be greater than 100.

In guinea-pigs it really seems that the influence of the mother is greater than that of the father, and this may be the explanation of the fact that the number of male guinea-pigs is greater than the number of females.

Finally, if the father has a greater influence on sex determination than the mother the number of descendants with a female tendency will be greater than the number with a male tendency, and consequently the sex ratio will be smaller than 100, as is shown by the following analysis:

Father with male tendency mated with mother with female tendency gives more males (female tendency) than females (male tendency). The father with female tendency mated with mother with male tendency gives more females (female tendency) than males (male tendency). Thus from either combination the greater number of offspring have a female-producing tendency and as a result of this the sex ratio will be less than 100.

Concerning the third factor, "C," the change of the sex tendency from litter to litter, a statistical examination shows the following results:

First: Relative number of male and female descendants after the birth of one or more females in one litter; 38 males to 12 females, *i. e.*, 76 per cent. males to 24 per cent. females (sex ratio 316.66).

Second: Relative number of male and female descendants after birth of one or more

males; 13 males to 38 females, *i. e.*, 25.49 per cent. males to 74.51 per cent. females (sex ratio 34.21).

To determine further whether the sex-tendency of males showed any inclination to change from mating to mating the records were counted in the following manner:

Taking the matings of given males following matings that produced only female young, it was found that the product of such matings consisted of 22 males to 27 females, *i. e.*, 44.90 per cent. males to 55.10 per cent. females (sex ratio 81.48).

Taking the matings of given males following matings that produced only male young, it was found that the product of such matings consisted of 28 males to 24 females, *i. e.*, 53.84 per cent. males to 46.16 per cent. females (sex ratio 116.66).

This result is therefore the reverse of that shown by the females. Whereas the females show an opposite tendency following each litter, the males always maintain the same tendency.

Only those litters which were purely male or female were used in the above consideration. After a mixed litter of males and females, which is more common under natural conditions, there is not a pure, but also a mixed sex tendency. This fact renders the recognition of the "C" factor extremely difficult.

Such a characteristic change in tendency from birth to birth also seems to occur in other animals. The daphnids, for instance, seem to have some such regulation very definitely expressed.[1] In these organisms also the sex tendency changes from generation to generation as well as from birth to birth in such a way that not after each generation and each birth, but after a number of generations and births, differing with different species, the exclusive production of parthenogenetic female ceases and the first males appear. Doubtless we have in this an example of a change of the sex tendency, but its expression is quite different from that in the guinea-pigs.

[1] Papanicolaou, G., "Experimentelle Untersuchungen über die Fortpflanzungsverhältnisse der Daphniden," *Biol. Zentralbl.*, 30, 1910.

From a theoretical standpoint, it is very important that coincidentally with the change of sex tendency in the summer eggs from female to male in *Moina rectirostris* var. *Lilljeborgii*, there is also a change in the color of these eggs from violet to blue.[2] This fact probably indicates that some chemical change occurs in the eggs at the same time that the change in the sex tendency takes place.

At the present time I am endeavoring to complete my observations and to determine statistically the relative value of the three factors in different combinations. Since, however, the animals at my disposal are designed especially for the study of the degenerative influence of alcohol, it will, no doubt, require a long period of time to collect hundreds of selected cases, since so few animals of the generations later than the third are capable of reproduction.

This preliminary report is published with the hope that other investigators, having a large stock of different animals at their disposal, may further contribute to the solution of this problem in all its details.

George Papanicolaou

Department of Anatomy,
Cornell University Medical College

[2] *Ibid.*

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SECTION C

The first session was held on the afternoon of Thursday, December 31, at the John Harrison Laboratory of Chemistry, Vice-president Edgar F. Smith in the chair, with an attendance of about 75. The following officers were elected:

Vice-president—William McPherson, Ohio State University.

Member of Council—W. T. Taggart, University of Pennsylvania.

Member of General Committee—L. W. Jones, University of Cincinnati.

Member of Sectional Committee—E. C. Franklin, Stanford University.

The section passed a resolution to the following effect: That the committee of Section C endeavor

to arrange its program so as to center round some definite topic or group of topics, the choice and treatment of which should preferably be such that they prove interesting and useful, even to any one not especially conversant with chemistry; and that Section C favors the relegation to the Chemical Society of unrelated papers of interest only to chemists, though this would in no wise preclude the holding of joint meetings with a local section of the Chemical Society or with any other society.

The following papers were read:

The Densities and Degrees of Dissociation of the Saturated Vapors of the Ammonium Halides:[1] ALEXANDER SMITH AND ROBERT H. LOMBARD.

The Entropy of Vaporization of Normal Liquids: J. H. HILDEBRAND.

A discussion of the value of the quotient Q/T (Q is the latent heat, T the temperature, of vaporization) and of its variations.

Chemical Preservation of Manure: P. A. MAIGNEN.

A plea for the better conservation of the valuable material at present going largely to waste as sewage.

A Rapid Lime Requirement Method for Soils without the Use of a Factor: THOS. F. MANNS.

A description of the method, illustrated by examples of the results attained.

On the Universal Application of the Molecular Theory. A Question: H. E. MORROW.

Suggests the possibility of dispensing with the conception of molecules in the case of complex colloids, such as proteins; that a conception of continuous atomic linkings serves to account for some of the properties which such complex substances exhibit.

On the forenoon of January 1, in the laboratory of hygiene of the University of Pennsylvania, Section C held a joint session with Section K and with the Society of American Bacteriologists, devoted to a symposium on "The Lower Organisms in Relation to Man's Welfare." The attendance was about 200. The list of speakers and titles follows; the papers will be published in full later.

Theories of Fermentation: C. L. ALSBERG.

The general mechanism of the action of ferments.

Enzyme Action: C. S. HUDSON.

A discussion of the chemical changes involved in the action of enzymes.

Rôle of Microorganisms in the Intestinal Canal: A. I. KENDALL.

Microorganisms in their Application to Agriculture: C. E. MARSHALL.

JOHN JOHNSTON,
Secretary of Section C

[1] See *J. Am. Chem. Soc.*, 37: 38, 1915.

THE FEDERATION OF AMERICAN SOCIETIES FOR EXPERIMENTAL BIOLOGY

THE second annual meeting of the Federation, comprising the American Physiological Society, the American Society of Biological Chemists, the American Society for Pharmacology and Experimental Therapeutics, and the American Society for Experimental Pathology, was held at St. Louis on December 28, 29 and 30, 1914, in the laboratories of the Washington University Medical School.

Three joint sessions of all of the above societies were held at which twenty-eight communications were presented. The titles of these papers have already appeared in the account of the meetings of the Physiological Society.[1]

At the first session the following memorial addresses were delivered:

"S. Weir Mitchell," by E. T. Reichert, read by W. B. Cannon.

"C. S. Minot," by F. S. Lee.

The following resolution was presented and unanimously adopted:

WHEREAS, various of the European nations with which many of our members are related by birth, descent or intellectual friendship are now at war,

Resolved, that we extend to the scientific men within these nations the hope of an early and enduring peace, which will leave the nations with no permanent cause of rancor towards each other, and which will insure to each the glories of scientific and humanitarian achievement in accordance with its own conception of these ideals.

Printed copies of this resolution, suitable for mailing, have been prepared and may be obtained from Professor Graham Lusk, Cornell Medical College, New York City. It is hoped that members of the Federation will send such copies with their compliments to their scientific friends in the countries now at war.

Executive Committee for the Year 1915.—Chairman, Torald Sollmann; *Secretary*, John Auer, for the Pharmacological Society; W. B. Cannon, C. W. Greene, the Physiological Society; Walter Jones, P. A. Shaffer, the Biochemical Society; Theobald Smith, Peyton Rous, the Pathological Society.

P. A. SHAFFER,
Secretary of the Executive Committee, 1915
WASHINGTON UNIVERSITY MEDICAL SCHOOL,
February 9, 1915

[1] SCIENCE, January 22, 1915, p. 142.

THE AMERICAN SOCIETY OF BIOLOGICAL CHEMISTS

THE ninth annual meeting of the society was held at St. Louis on December 28, 29, 30, 1914, in the laboratories of the Washington University Medical School. Three joint sessions were held with the other societies composing the federation in addition to two sessions conducted independently.

The following communications were presented at the independent sessions of the society and from this society at the joint sessions. The titles of other papers which were presented from the other societies at the joint sessions have been given in the account of the meetings of the Physiological Society.[1]

"The Influence of Food on Metabolism," presidential address, by Graham Lusk.

"The Excretion of Creatine During Fasting," by F. D. Zeman (by invitation) and P. E. Howe.

"The Determination of Creatine and Creatinine in Urine; and the Occurrence of Creatine," by J. L. Morris (by invitation).

"A Method for Determining and Comparing the Local Toxicity of Chemical Compounds," by H. J. Corper.

"Experiments with Pure d-l-Glyceric Aldehyde," by R. T. Woodyatt.

"The Level of Sugar in the Blood Flowing from the Liver under Laboratory Conditions," by J. J. R. Macleod and R. G. Pearce.

"The Level of Blood-sugar in the Dog," by P. A. Shaffer and R. S. Hubbard (by invitation).

"A Method for the Decomposition of the Proteins of the Thyroid with a Description of Certain Constituents," by E. C. Kendall.

"Variations in Factors Associated with Acidity of Human Urine During a Seven-day Fast and During the Subsequent Non-protein and Normal Feeding Periods," by F. D. Zeman (by invitation), Jerome Kohn (by invitation) and P. E. Howe.

"The Mechanism of the Toxicity of Halogen Narcotics," by E. A. Graham (by invitation).

"On the Relation of the Oxygen Tension of the Atmosphere to Combustion," by H. C. Dollwig (by invitation), A. C. Kolls (by invitation) and A. S. Loevenhart.

"The Influence of Sodium Carbonate on the Glycosuria, Hyperglycæmia and the Respiratory Metabolism of Depancreatized Dogs," by J. R. Murlin and B. Kramer (by invitation).

"The Possibility that Some of the Hepatic Glycogen May Become Converted into other Substances than Dextrose," by J. J. R. Macleod.

"Narcotics in Phlorhizin Diabetes," by R. T. Woodyatt.

"Some Studies in Autolysis," by H. C. Bradley.

"On the Nature of the Hepatic Fatty Infiltration in Late Pregnancy and Early Lactation," by V. H. Mottram (by invitation).

"The Synthesis of Hippuric Acid in Experimental Tartrate Nephritis in the Rabbit," by F. B. Kingsbury (by invitation) and E. T. Bell (by invitation).

"The Determination of Blood Sugar" (demonstration), by P. A. Shaffer.

New Members—Olaf Bergeim, Jefferson Medical College, Philadelphia, Pa.; Alex. T. Cameron, University of Manitoba, Winnipeg, Canada; G. H. A. Clowes, Gratwick Laboratory, Buffalo, N. Y.; B. M. Duggar, Missouri Botanical Garden, St. Louis, Mo.; Cyrus H. Fiske, Harvard Medical School, Boston, Mass.; R. A. Hall, University of Minnesota, Minneapolis, Minn.; C. G. Imrie, University of Toronto, Toronto, Canada; Benjamin Kramer, State University of Iowa, Iowa City, Ia.; A. Bruce Macallum, University of Toronto, Toronto, Canada; J. F. McClendon, University of Minnesota, Minneapolis, Minn.; J. Lucien Morris, Washington University Medical School, St. Louis, Mo.; Max Morse, University of Wisconsin, Madison, Wis.; V. H. Mottram, McGill University, Montreal, Canada; C. F. Nelson, University of Kansas, Lawrence, Kansas; E. L. Ross, Northwestern University Medical School, Chicago, Ill.; E. C. Shorey, U. S. Department of Agriculture, Washington, D. C.

Officers Elected—The following officers were elected for the year 1915:

President—Walter Jones.

Vice-president—Carl L. Alsberg.

Secretary—P. A. Shaffer.

Treasurer—D. D. Van Slyke.

Additional Members of the Council—Otto Folin, Graham Lusk, L. B. Mendel.

Nominating Committee—J. J. Abel, S. R. Benedict, H. D. Dakin, P. B. Hawk, J. J. R. Macleod, E. V. McCollum, V. C. Myers, T. B. Osborne, A. N. Richards.

Abstracts of the papers presented will be published in the *Journal of Biological Chemistry*.

P. A. SHAFFER,
Secretary

WASHINGTON UNIVERSITY MEDICAL SCHOOL,
ST. LOUIS, MO.

[1] SCIENCE, January 22, 1915, p. 142.

SCIENCE

FRIDAY, MARCH 19, 1915

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE CLASSIFICATION OF NERVOUS REACTIONS[1]

IT is within the memory of most of us what a distinct advance was made in the definiteness of our thinking about nervous reactions when the introduction and improvement of the Golgi method led up to the conception of the neurone doctrine. Previous to that time our mental picture of the reflex mechanism was not essentially incorrect; but its conception of the nature of the connection between the sensory fiber and the motor nerve cell was indefinite. When the new histological method revealed the posterior root fibers entering the cord and by means of collaterals ending in the immediate neighborhood of motor cells, there was revealed an almost diagrammatic mechanism which explained many reflex phenomena; and we can recall the enthusiasm with which all proceeded to construct combinations of neurones to serve as the anatomical basis of the various known functions of the nervous system; indeed, we have been engaged in this fascinating pastime ever since.

This is exactly as it should be, for only in this way could the possibilities of the new discovery be tried out. There is danger, however, in anything which is attractively definite; sometimes because it may belong among those things which are "too good to be true"; but more frequently because its successful explanation of many of the phenomena with which it deals may blind us to its failure to explain others;

[1] Address of the chairman and vice-president of Section K (Physiology and Experimental Medicine), American Association for the Advancement of Science, Philadelphia, December 31, 1914.

and I think there are to-day, even among those who do not follow Apathy and Bethe in their undiscriminating attacks on the neurone theory, many who are seriously asking whether the neurone conception of the reflex exhausts the possibilities or nervous mechanisms.

For, after all, the distinct service of the neurone theory is its explanation of the mechanism of reflex action. It gives us a satisfactory explanation of simple and even of highly coordinated reflexes; but there are still left problems upon which its staunchest defenders will not claim that it throws much light. The contribution, for example, of the cerebellum to the execution of volitional or reflex actions is not self-evident in terms of the theory; the mechanisms of reenforcement and facilitation (Bahnung) are no more easily pictured now than before; and, above all, the whole field of cerebral physiology may be said still to be in the same state as was that of reflex action before Golgi made that fortunate mistake of putting some pieces of spinal cord which had been hardened in Müller's fluid into silver nitrate and beheld for the first time a nerve cell in all its glory.

The diagrammatic clearness of the picture of the reflex mechanism thus revealed has contributed largely to our present mental approach to the problems of neurology, an approach which is faithfully reflected in our text-book presentations of the subject. The first text-book chapter is largely anatomical, chiefly histological; the next chapter deals with reflex action which is presented to the student as par excellence the typical nervous action; the treatment of the subject then proceeds from the simpler reflexes to those requiring a higher degree of coordination; accustomed movements, such as those of locomotion, receive their explanation as an endless chain of reflexes requiring for its operation the structures of the mid- and 'tween brains; finally the attempt to explain everything in terms of reflex action is carried into the field of cerebral physiology. With what success? One has only to read the textbooks to find out. Some things, especially localization, are dwelt upon at length; the possibilities of excessively complex coordinations are suggested by the anatomical structure; but we miss entirely the satisfaction of seeing the cerebral functions clearly pictured in terms of neurone structure. We trace the "way in" and the "way out"; we see that the connection between the afferent and efferent nerve fibers is in the cortex; but what takes place in the cortex? Is it objectively nothing more than our typical reflex raised to the *n*th power of complexity? Perhaps it is; but does any one feel reasonably sure of it? For one, I confess I do not.

However that may be—and I have no intention of discussing the question—this much may certainly be said. We know that there are nervous actions which are not reflexes at all; furthermore, there are nervous actions which usually pass as reflexes, although they present striking and perhaps fundamental points of difference from the typical reflex arc of our neurone theory. The justification of these statements will be attempted in what follows. My present purpose and indeed the purpose of this paper is to challenge the wisdom of making the reflex arc the type of all nervous action either in our own thinking or in the presentation of the subject to students, and to suggest that we would act more wisely to cultivate a more open state of mind with regard to the existence of other possibilities.

This may be done, it seems to me, by drawing sharply the distinction at the outset between the following classes of nervous

action: automatic, axon reflex, unconditioned reflex, conditioned reflex and volitional. It is not claimed that this list is exhaustive. The physiology of such mechanisms, for example, as the plexus of Auerbach is at present too little understood to admit of successful classification. It is only claimed that the above are distinct forms of nervous activity; that they are carried out by different mechanisms, and that, as such, they should be given coordinate rank in the student's mind.

In the following discussion I shall not include any treatment of volitional action. I am concerned only with the proper classification of nervous actions and see no reason for changing the all but universal custom of placing volitional actions in a class by themselves. I shall, however, dwell at some length upon the automatic action, the axon reflex, and then discuss together the conditioned and the unconditioned reflex.

AUTOMATIC ACTIONS

In general an automatic action is one which originates in the mechanism involved and is not caused by any external influence acting only at the time of its occurrence. The ticking of a clock is an example. In the field of physiology we think at once of the beat of the heart, although other no less striking examples are known; a strip of the muscular coat of the stomach or intestine shows automatic contractions; and many of the processes of embryological development probably belong in the same category. Contrasted with these are skeletal muscles and many glands which become functionally active only in response to some sort of external stimulus, usually a nerve impulse.

Even in the case of the skeletal muscle, however, the external stimulus seems to act by causing the accumulation, and probably the localized accumulation of some physical or chemical condition within the cell leading to the discharge of energy. Thus an attractive theory of electrical stimulation of skeletal muscle supposes that certain semipermeable membranes within the muscle fiber are more permeable to ions of one electrical charge than to those of the opposite charge; hence in the migration of the charges to the two electrodes during the passage of a current there results an accumulation of electric charges at these membranes; and when this has gone on to a certain extent, the electrical condition thus created explodes an unstable fuel substance, energy is liberated and contraction results. The passage of the stimulating current has merely produced the accumulation of what may be called the "discharging conditions" within the cell.

In the automatic action these discharging conditions seem to accumulate without external assistance, possibly as the result of certain metabolic processes in the cell itself. External conditions, such as temperature, may influence the rate or the amount of discharge; but this does not make these external conditions stimuli in any true sense. Furthermore, we may speak, if we will, of the whole chain of events leading to the accumulation of the discharging conditions as an "inner stimulus"; but this would seem to involve an unnecessary and even questionable extension of the term stimulus.

An automatic nervous action is frequently defined as a discharge from a nerve cell caused by some other external stimulus than that of an exciting neurone; but, if the cell is discharged by an external stimulus of any kind, the action is not automatic. What we observe in such cases is activity, apparently, at any rate, arising within the cell itself, and we have no more

logical right to assume an unrecognized stimulus than in the case of the ticking of a clock. In the absence of knowledge to the contrary, the presumption is that the cell is discharged by the operation of its own never ceasing metabolism.

In our usual teaching as well as in our usual thinking it is customary to take account only of (1) the stimulus and (2) the reaction, and to regard each of these as a single process; whereas all the evidence goes to show that between the ordinary external stimulus, at any rate, and the release of energy there is usually interpolated a third process, which we have termed the "accumulation of discharging conditions" in our brief reference to the nature of electrical stimulation. We again meet with the suggestion of a similar process in the case of stimulation by a nerve impulse. Langley's work on the antagonism of nicotin and curare, as well as that of Keith Lucas on the "characteristic" of stimulation in different tissues, has led to the assumption of a "receptive substance" in skeletal muscle. The action of adrenalin also points to a similar "receptive substance" connected with the endings of the post-ganglionic automatic neurones. And yet is not this term "receptive substance" or "receptor" merely a name to hide our ignorance? and do we not really mean a physical or chemical process carried out by the cell protoplasm, as a whole, rather than a specialized irritable substance; a process, in other words, which results in the accumulation of "discharging conditions"? If this point of view is correct we must distinguish sharply between the stimulated action and the automatic action; they are alike in the second and third of the above-mentioned processes; they differ in that the accumulation of discharging conditions comes in the stimulated action as the result of an external influence (electric shock, nerve impulse, or mechanical blow), while in the automatic action it results presumably from the cell metabolism.

In the central nervous system the best known and most successfully studied case of automatism is that of the respiratory center. The conclusion which Rosenthal drew from his experiments, that the nerve cells of this center send out rhythmic discharges when removed from all connection with afferent nerves, has been confirmed by all subsequent work, the experiments of Winterstein being especially conclusive on this point. Here again we are probably dealing with the development within the nerve cell of discharging conditions which may be influenced by the character of the environment, such as the tension of carbon dioxid or the concentration of hydrogen ions, or temperature or the presence of certain drugs; and we may repeat that there is no justification for speaking of these as stimuli, as we generally do. So far as the facts go, we may logically regard them only as external conditions which regulate the rate of development of the automatic cell processes or the character of the discharge which it evokes from the cell.

Until recently no other case of automatic nervous action was known. Some may have been suspected in the vaso-motor system or in the myenteric plexus; but no facts compelled the conclusion that they must be regarded as automatic actions. Recently, however, facts have come to light which argue strongly for an automatic basis to the nervous mechanism of locomotion. These movements, as already stated, have in the past presented to us the picture of an endless chain of reflexes, in which the afferent neurones are mostly the nerves of muscular sense, the complex of instreaming afferent impulses, ever changing as the movement proceeds, giving the

appropriate stimuli to the successive movements, which eventually come back to the starting point and so lead to the repetition of the series. To avoid misunderstanding, it may be well to say at the outset that no one denies that afferent impulses play an important rôle in locomotion. The phenomena of locomotor ataxia are conclusive evidence on that point; but so do afferent impulses over the pulmonary fibers of the vagus nerve play an important rôle in regulating the fundamentally automatic discharge from the respiratory center, without being in any way its exciting cause. The work of T. Graham Brown[2] suggests that the same thing is true of the rhythmic movements of locomotion. Brown shows that in a certain stage of ether narcosis in the decerebrate animal, when reflexes can no longer be elicited from the afferent nerves, rhythmic movements of flexion and extension occur in the hind legs; and furthermore, that these movements occur after the afferent nerves from the moving limbs are cut. In other words, these movements which suggest the basis of the movements of locomotion, involving as they do the alternate rhythmic action of antagonistic groups of muscles, are executed by efferent neurones without any stimulation from afferent neurones. They constitute an "endless chain," but not an endless chain of reflexes.

This discovery seems to me to be of sufficient importance to justify dwelling upon it at some length; and in order to obtain a clear picture of the possibilities, we may give briefly Brown's very plausible hypothesis of the nature of the nervous mechanism involved. A movement of this kind consists fundamentally in the alternate contraction of antagonistic groups of muscles. We may denominate the nerve cells innervating each antagonistic group as a half-center, the two together making the entire nerve center for the given movement. Brown supposes that each half-center sends inhibiting collaterals to its antagonist (reciprocal innervation of Sherrington), so that when the flexors, for example, are being excited, the extensor neuro-muscular mechanism is inhibited. He then assumes that the efficiency of this inhibition rapidly diminishes—somewhat as the heart escapes from vagus inhibition —either by the fatigue of the inhibitory mechanism or by the increase of the discharging power of the inhibited cells. The result is that in a short time the inhibited center breaks through its inhibition, excites its muscles to contract and at the same time inhibits the previously active antagonistic half-center.[3] The repetition of these processes leads, of course, to the rhythmic movements referred to.

Brown further raises the very interesting question whether these automatic actions of locomotion do not present a more primitive form of nervous activity than the reflex. He points out the difficulty of imagining the origin of a reflex arc by natural selection, since neither the afferent nor the efferent limb would be of any use to the animal without the other; and it is almost impossible to conceive of both arising at the same time by any assumed process of evolution. It is far more easy to

[2] T. Graham Brown, *Journal of Physiology*, 1914, XLVII., p. 18.

[3] This theory assumes that the cells of both half-centers are automatic and subject to the same environmental conditions (*e. g.*, tension of carbon dioxid) governing their discharge. If both centers were in exactly the same physiological condition and subject to the same environmental conditions, they would discharge simultaneously and alternate rhythmic contractions of antagonists would be impossible. This condition of equal irritability, however, is rarely realized. When it does not obtain, one half-center will discharge first and, as explained, inhibit for the time being the discharge of the other.

suppose that the primitive nervous mechanism is the automatic one seen at work in the movements of narcosis progression. These would serve in the simplest animals the purpose of progression which may reasonably be regarded as among the first functions of coordination a nervous system would be likely to serve. In other words, the nervous mechanism of locomotion, like the nervous mechanism of respiration, is fundamentally an automatic mechanism. Later on afferent neurones are added to it, comparable to those of the pulmonary branches of the vagus. In this connection it is most significant that in general the same conditions so frequently referred to as stimuli of the respiratory center—lack of oxygen, excess of carbon dioxid, etc.—are the very conditions found to favor the movements of narcosis progression.

If, then, to the respiratory center, which has thus far stood in lonely glory as the one fully established example of automatic nervous action, we must add the fundamental centers of locomotion, the thought at once suggests itself that renewed investigation may find the same thing true of other actions which in the past we have too complacently catalogued under the head of reflexes. The field thus opened up is a large one.

AXON REFLEXES

Text-books of physiology usually record two observations, one by Langley, the other by Bayliss, which were not suspected of bearing any relation to each other and both of which have been difficult to fit into the orthodox scheme of nervous action. So far is this true that Langley's axon reflex has been relegated to the inglorious place of a laboratory curiosity which plays no rôle in normal life, while Bayliss's proposed theory of antidromic impulses has been treated with a polite but uncompromising skepticism.

The axon reflex is a reaction made possible by the branching which generally takes place at the end of an axon. Inasmuch as nerve fibers can conduct impulses in both directions, it follows that stimulation of one of the terminal branches will start an impulse traveling up to the point of union of the two branches, and then down the other branch to the end organ. The axons to a frog's sartorius, for example, branch soon after entering the muscle and it often happens that one branch will go to one side of the muscle, while another branch of the same neurone will pass to the opposite side. If, now, the lower third of the muscle be divided longitudinally, it is found that a stimulus applied to one half so as to excite its nerve fibers will cause contraction of the opposite half of the muscle. The same thing is rendered possible whenever a preganglionic efferent neurone passes through several sympathetic ganglia, giving off collaterals to postganglionic neurones in successive ganglia; in this case stimulation of the terminal branch of the preganglionic neurone will start an impulse centripetally and excite, through the collaterals, the cells with which these collaterals are connected. It is also well known that one must be on his guard against axon reflexes in testing the regeneration of nerve fibers, for it often happens that in the process of regeneration an axon of the central stump may branch before entering the peripheral stump; if these two axon branches find their way into different branches of the peripheral nerve trunk, stimulation of one of these branches may give an apparent reflex, which, however, is only an axon reflex.

These and other examples that may be cited are, however, only laboratory curiosities. Where the two branches of the axon end in a muscle or a gland neither branch can be stimulated at its ending except by

artificial means. If, on the other hand, the same axon should send one branch to a sense organ and another to a muscle, or gland, or blood vessel, we would have the possibility of an axon reflex as a normal event. Recent work suggests that this possibility may be realized.

In 1901 Bayliss[4] found that stimulation of the posterior roots of the sacral nerves between the ganglion and the cord produces dilation of the blood-vessels of the hind limb. The natural explanation of the result, that certain vaso-dilator neurones may send their axons out by the unusual path of the posterior instead of the anterior nerve roots, was disproved by the fact that if the posterior roots are cut near the cord and degeneration allowed to occur, stimulation of the peripheral stump of the cut root still produces the dilation. In other words, the ganglion of the posterior root is the trophic center for some of the essential fibers concerned. From consideration of the known histological possibilities Bayliss concluded that the fibers producing the dilation are the ordinary afferent fibers from the pear-shaped cells of the ganglion, the distal axon being supposed to branch at its ending, one branch going to the sense organ, and the other to the blood-vessel. He furthermore supposed that in addition to serving as a trophic center for the afferent fiber, these cells may be reflexly stimulated by other afferent fibers and thus discharge "antidromic" impulses to the periphery; such impulses passing over the branch to the blood-vessel produces the dilation, while the impulse over the branch to the sense organ would be without effect ("law of irreciprocal conduction"). Physiologists have, however, looked askance on this conception of antidromic impulses, even as a working hypothesis.

The very important experiments of Bruce,[5] however, put the matter in a new light. It is well known that when an irritant is applied to the skin, a dilation of the arterioles (active congestion) ushers in the inflammatory reaction. Bruce shows that this will not occur if the area to which the irritant is applied is first rendered anesthetic with cocaine. It will occur immediately after section of the anterior roots or of the posterior roots, either centrally or distally of the ganglion; hence it is not a reflex through the cord or the ganglion. It will not occur, however, after the completion of the peripheral degeneration consequent upon section of the posterior root distally to the ganglion. In other words, it would seem to depend solely upon the integrity of the distal limb of the neurones of the posterior roots, and to be independent of any nerve cell whatever. This would seem almost to force[6] the conclusion that we are dealing with an axon reflex. The posterior root fiber branches, as Bayliss supposed, at its ending, one branch going to the sense organ while the other serves as a dilator of the arterioles. The same fiber, probably one of pain, which carries the afferent impulse giving rise to the sensation of irritation produces also the active congestion of the region through its vascular collaterals.

If these observations prove well founded, the axon reflex becomes a reality in the normal functioning of the organism, instead of a laboratory curiosity. Moreover, the facts discovered by Bayliss receive their

4 Bayliss, *Journal of Physiology*, 1901, XXVI., 173; *ib.*, 1902, XXVIII., 276.

5 A. Ninian Bruce, *Quarterly Journal of Exp. Physiology*, 1913, VI., p. 339.

6 The writer can imagine only one other possibility; namely, collaterals given off from afferent fibers distally to the ganglion may enter the sympathetic ganglia, which would thus serve as reflex centers. No such collateral communications in nerve trunks have, however, been described. Indeed it is the usual teaching that nerve fibers branch only in the ganglion or at their endings.

ready explanation without the help of the hypothesis of antidromic nerve impulses. Furthermore, if the axon reflex is the foundation of this inflammatory reaction, we may well investigate other reactions which in the past have been classed as reflexes, but upon inadequate evidence. So long as the reflex was supposed to be the only means by which stimulation of a peripheral sense organ can evoke a non-volitional reaction in another organ, all such reactions have been classed as reflexes, and this quite frequently without experimental proof.

CONDITIONED AND UNCONDITIONED REFLEXES

The main purpose of this paper is to emphasize neglected aspects of nervous action. Hence our treatment of reflexes, properly so-called, will be confined to emphasizing the fact that we probably include in the category of the reflex two entirely different kinds of nervous reaction.

It is an interesting fact that so common a phenomena as reflex action is somewhat loosely defined in our thinking. One will call it an action brought about by the stimulation of efferent neurones by one or more afferent neurones; another will add to this, "without the intervention of the will"; another will add, "without the causal intervention of consciousness"; while still another will add, "without the causal intervention of consciousness or the will." These four definitions are by no means identical, as I hope to show. All of them have in common the fact of stimulation of efferent by afferent neurones, stimulation being supposed to include both excitation and inhibition, and it being assumed that any number of intermediate neurones (first, second and third order, etc.) may be interposed between the afferent and the efferent nerves concerned. All would exclude the will from any causal connection with the reaction, and this leaves as the chief point of difference in the above definitions the question whether we should exclude from the category of reflex action all cases where the nervous processes concerned in consciousness play, or seem to play, a causal rôle in the chain of events; for there are nervous actions which are in no sense volitional; which have an afferent and an efferent side, and hence resemble reflexes; but in which we encounter the nervous actions concerned with consciousness. The example which at once occurs to us is the so-called psychic secretion of saliva and gastric juice. To these we would add the no less striking case, brought to our attention by Cannon, of the stimulation of the secretion of adrenalin as the result of the major emotions of fear and anger. In all these cases there is the absence of conscious intention; indeed, the subject is unaware that the act of secretion is taking place; and yet the conscious process is the starting point of the efferent discharge. Shall we or shall we not call such actions reflex actions?

The answer to this question is, of course, entirely a matter of arbitrary definition. If we exclude the causal interposition of consciousness[7] from the reflex, such reactions are not reflexes; if we do not exclude it, they are. The decision in such an arbitrary matter, moreover, is determined on purely utilitarian grounds. Definitions exist only to insure clear thinking by keeping separate and distinct those things having some fundamental point of difference. Thus many would have us believe that there is no really fundamental difference between reflex and volitional acts; that the efferent discharge in the simplest reflex is accompanied by a momentary flash of something that corresponds to conscious intention;

[7] To avoid a cumbersome expression, the word "consciousness" is frequently used for the "nervous events connected with the state of consciousness."

and that there are all gradations between this and the highest development of the human will. Perhaps they are right; we will not argue the point; but we nevertheless retain our two categories of reflex and volitional actions, because so long as this conception of volition is a pure hypothesis it is unwise to forget that what are subjectively different may be objectively different as well.

The same principle of definition should be applied to the case under discussion. A reflex from which consciousness is entirely absent and one in which consciousness seems subjectively to play a causal rôle may, from the objective standpoint, be one and the same thing; and yet so long as this is only one of two opposing tenable hypotheses, it would seem to be the sensible thing to make a distinction between them.

One of the world's most eminent physiologists does indeed make such a distinction. I refer to Pawlow's differentiation between the unconditioned and the conditioned reflex. I can hardly think that Pawlow's very striking experiments upon which he bases this distinction are unknown to physiologists generally and all will agree that he is a man whose opinion should command attention; yet I find no notice whatever of this matter in the three admirable text-books of physiology which are most widely used to-day in England and America. Because of this and in view of the fact that this address is to a semi-popular audience I shall go into this matter at somewhat greater length than if I were speaking to specialists in neurology.

The distinction between the conditioned and the unconditioned reflex is well illustrated by the excitation of salivary secretion through the nervous system. When the taste endings are excited by food in the mouth, a purely reflex flow of saliva results. The work of Miller[8] seems to establish the existence of definite bulbar centers for this reaction, the gustatory fibers of the lingual and the glossopharyngeal nerves serving as the afferent neurones. On the other hand, the mouth may water "at the very sight of food." Here the afferent stimulus comes through the optic nerve, but it differs from that through the gustatory fibers in the fact that the reaction is secured only in a conscious animal. It is also more capricious in its occurrence; the whole setting of the nervous system must be right to have it occur at all; the subject must be hungry, the food must be appetizing, it is more apt to occur at the accustomed hour for meals. In short, a certain state of consciousness must exist to insure effective connection between the afferent optic neurones and the secretory efferent neurones. In the unconditioned reflex the nervous processes concerned in consciousness are in no way involved; it will take place in a decerebrate animal and may occur under anesthesia; it is a rare thing that the application of the proper stimulus fails to elicit it, although, like any other reflex, it may be inhibited, as in the old rice test. Above all, it is not easily lost by disuse, perhaps never permanently lost except by some actual atrophy of the neurones involved.

In a remarkable series of experiments Pawlow[9] actually developed in animals conditioned reflexes which could by no possibility have formed part of the previous life of the animal or of its ancestors. Every time a dog was fed, a piece of ice was applied to a certain part of its skin. In the

[8] F. R. Miller, *Quar. Jour. Experimental Physiology*, 1913, VI., 57.

[9] Pawlow, I. P., Huxley Lecture for 1906, *British Medical Journal*, 1906, Vol. II., p. 871; *Lancet*, 1906, Vol. 171, p. 911; SCIENCE, 1906, N. S., XXIV., p. 613; see also Pawlow's articles on the same subject, *Ergebnisse der Physiologie*, 1904, III., 1, p. 177; *ib.*, 1911, XI., p. 345.

course of time (ten days or two weeks) the application of the ice to the same cutaneous area would evoke a flow of saliva without the formality of feeding. The application of ice to other parts of the skin was also effectual, apparently because the sensations of cold concerned in the result were not local, but more or less generalized. In another series of experiments a note of a certain pitch always accompanied the taking of food, and this stimulus, too, after sufficient repetition, could evoke the flow of saliva, while a note of distinctly different pitch was ineffectual. The reactions thus acquired were soon lost with disuse, although it is possible that if the "training" had been continued over much longer periods of time the reactions might have become more firmly fixed; it is even conceivable that they may take place in the absence of consciousness; that is to say, without the participation of cerebral centers; but these are questions which, so far as I am aware, experiment has not yet answered. Finally, they are more or less capricious; not infrequently the acquired response to the stimulus does not occur, thus contrasting with the response to gustatory stimulation, which seldom fails.

In what way is this type of reaction acquired? The phenomenon of reenforcement (of the knee jerk, for example) shows that activity of any one part of the nervous system causes the irradiation over the entire brain and cord of some exciting influence which, though itself minimal or even subminimal, yet adds itself to any other stimulus that may enter about the same time. Pawlow's work seems to show, moreover, that, when two nerve centers are habitually active at the same time, there is beaten out a path of conduction between the two, the two become "associated" so that activity of the one is liable to excite activity of the other. When, for example, the knee jerk is reenforced by stimulus of sound, not only does such an irradiation from auditory centers pass to all parts of the nervous system, the sacral motor centers included, but one also irradiates from the sacral centers to all parts of the nervous system, the auditory centers included; and just as when there are two lights in a room the path between these lights is the most intensely illuminated portion of the room, so in the case in question the path between the two centers is most strongly in the excited state. If now this same combination of activity be repeated over and over again, this path becomes more irritable and conductive by use until we arrive at the condition shown in the above experiments of Pawlow where activity of one center can, of itself, excite activity of the other. It would indeed be interesting to know whether, just as clapping the piece of ice on the skin evoked a secretion of saliva, so the dog experienced a sensation of cold every time he ate.

The path of conduction or association thus established is presumably through the gray matter, perhaps with the help of the short neurones of the border zones.[10] Our present knowledge of the anatomy of the nervous system is inadequate to give a satisfactory idea of the mechanism involved in the development of this new path of conduction; but it is inconceivable that the anatomical basis of the physiological connection between the centers in question should be the same as that pictured in the typical reflex arc of the text-books. Apart from the improbability of the development of new neurones, the observed facts of the capriciousness of the reaction and the ease with which, once acquired, it is lost by disuse determine as the logical course its provisional classification in a group of its own.

[10] One thinks of the "neuropile" of some histologists as a possible tissue in which this path is blazed.

To look at the matter from another point of view, the present state of our knowledge would seem to indicate that the typical reflex of our text-books, the unconditioned reflex, is a congenital mechanism. The neurones concerned and the collateral connections of afferent and efferent limbs are born with us. It may require practise to bring the mechanism into perfect working order; but practise does not produce a new neurone nor have we any reason for thinking it can produce collateral connections which were not already laid down by heredity. The nervous element in locomotion is a case in point. The colt walks from the moment of birth; a human baby not until its second year, and then only after arduous trial and effort; but this does not mean that the nervous mechanism is congenital in the one case and acquired in the other; it merely means that the congenital nervous mechanism is in complete working order at birth in the colt, while in man either embryological development is not complete until later or else use is required to make congenital synaptic connections efficient. Despite the immemorial antiquity of the expression "learning to walk," it may well be questioned whether any child really learns to walk; whether the facts observed are not equally well explained on the theory that the child finally walks simply because at last the embryological development of its nervous mechanism of locomotion is complete, as is that of the colt at birth; and that the improvement which apparently results from its efforts is in point of fact merely the record of the progress of ontogenetic development.

With learning to talk the case is entirely different. Here there is no inherited mechanism leading to a uniform result in all individuals of the species. One child learns to speak English, another German, another Russian; and if the English child had been taken after the first few months of its life to Russia and heard nothing but Russian, it would have learned to speak Russian as perfectly as it actually learned to speak English while growing up in its native country. In this case heredity has furnished a nervous system capable of acquiring just such associations as those described in Pawlow's experiments; we are dealing with a process in every way comparable to the conditioned reflex.

Finally, if the distinction between conditioned and unconditioned reflexes upon which Pawlow insists is correct, some old statements which take us back to our very introduction to the study of physiology need revision, or at least more accurate restatement. When we speak of "habit being an acquired reflex" we really mean an acquired conditioned reflex. There is no reason for assuming that the reflex acquired by the repetition of volitional acts is the typical reflex arc; indeed there is every reason for believing the contrary. Paths of conduction become blazed between different lower centers because they are simultaneously excited in the volitional execution of an action, and a mechanism is acquired of whose nature we know next to nothing, but through which the act can be performed more and more easily with less and less conscious effort—or, in physiological language, with less and less participation on the part of the higher centers of the cerebrum. We are not concerned with the psychology of this phenomenon, much less is this the place for speculation as to the physiological mechanism involved. We are simply concerned with its classification as a distinct thing from the ordinary unconditioned reflex.

Perhaps when introducing this discussion of reflexes I laid undue emphasis on the rôle of consciousness in the acquisition of conditioned reflexes. In the examples

cited the nervous events associated with the state of consciousness do indeed play a conspicuous rôle. If, however, the essential thing about this reaction is what we have suggested, namely, that the connection between afferent and efferent fibers is a path blazed through the nervous substance rather than a definite localized conduction through specialized neurones, it would seem that consciousness comes so frequently into play merely because it is through the nervous substance of the cerebrum that such paths can be blazed most readily, and the activity of cerebral centers carries with it as a usual thing a state of consciousness. If this be true there is no reason why conditioned reflex associations may not arise between subcortical as well as between cortical centers; it is only necessary that the centers be simultaneously active, reflexly or otherwise; and possibly some cases of associated action of two bulbar or spinal centers—respiratory and vaso-motor, or respiratory and cardio-inhibitory—may be of this kind rather than distinct collateral connections between the neurones of the two centers. This is, of course, only a surmise, but it is clearly a possibility and certainly there is no evidence whatever to exclude it. We have been too quick to assume that coordinations are always effected by the same mechanism, and that too the kind of mechanism pictured in our typical reflex arc. An unproved assumption; and so long as it is an unproved assumption it is the logical thing to keep in separate categories the two classes of reactions which to-day are almost universally thought of as one and the same.

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THE DEDICATION OF THE NEW BUILDING OF THE MELLON INSTITUTE

THE new $350,000 building which will form the permanent home of the Mellon Institute of Industrial Research and School of Specific Industries of the University of Pittsburgh, was formally dedicated on February 26. This building, the gift of Messrs. Andrew William and Richard Beatty Mellon, of Pittsburgh, was especially designed for the needs of the institute; it is distinctly modern in every respect, and complete facilities are provided for the investigation of manufacturing problems and for conducting industrial research according to the practical system of cooperation between science and industry, founded by the late director of the institute, Dr. Robert Kennedy Duncan. By this system, an industrialist having a problem requiring solution may become the donor of a fellowship by providing the salary of the researcher selected to carry out the investigation desired, the institute supplying every facility for the work—laboratory space, the necessary apparatus and supplies, library facilities and advice of a staff expert in industrial research, etc.

The new home of the Mellon Institute is a five-story and attic building. The basement contains seven rooms: the main storeroom, the boiler room, the electric furnace room, a heavy apparatus room, a room equipped for low-temperature work, the machine shop and a kitchen. On the first, the main floor, are located the general office, the director's suite, the office of the editorial department, the library, the office and laboratory of the assistant directors, the assembly hall, a special apparatus room and a dark-room laboratory. The second and third floors each contain ten large research laboratories and nine small ones; the fourth floor, which is not finished, will contain an identical number of laboratories as soon as the growth of the institute warrants its completion.[1] At the present time twenty-three fellowships are in operation and forty research chemists are engaged in a study of the variety of industrial problems under investigation at the institute.

While the Mellon Institute possesses an endowment of its own and has its own board of trustees, it is an integral part of the Univer-

[1] For a full description of the new building of the Mellon Institute, see *The Journal of Industrial and Engineering Chemistry* for April, 1915.

sity of Pittsburgh. The dedicatory exercises were accordingly held in conjunction with the annual charter-day exercises of the university.

The chancellor of the university, Dr. Samuel Black McCormick, presided at the dedication ceremonies, which took place at 11:00 A.M. in Soldiers' Memorial Hall. Following the address of the day by Dr. Rossiter Worthington Raymond, the dean of American mining engineers, on "Knowledge and Research," Dr. W. J. Holland, director of Carnegie Museum and formerly chancellor of the university, made the presentation speech in connection with the dedication of the Mellon Institute, on behalf of Andrew W. and Richard B. Mellon, the donors. After a brilliant eulogy of the Messrs. Mellon and a splendid tribute to their generosity, Dr. Holland said in part:

In a certain sense, Mr. Chancellor, this building is a memorial to Robert Kennedy Duncan. On one side of the entrance is a bronze slab inscribed with the name of Thomas Mellon; on the other side of the entrance is a bronze slab inscribed with the name of Robert Kennedy Duncan. But, Mr. Chancellor, this splendid edifice erected upon the campus of our university is more than a cenotaph. It not merely commemorates the names and careers of those of whom I have spoken, but it is intended to serve as the seat of advanced inquiries along scientific lines, which will tend to the promotion not merely of intellectual culture, but of industrial success, and that not merely in this great "workshop of the world," where it is located, but throughout the land. In creating this institution our dear friends have been actuated by a high and intelligent purpose. Large experience in great industrial enterprises has taught them the importance of chemistry and physics in their application to the industrial arts, and they feel that, wonderful as has been the progress made within the last century, there are untold mysteries in nature which have not yet been revealed, but which, if uncovered, are capable of being used for the welfare of mankind. And so they have created and are to-day placing in the custody of you, gentlemen of the board of trustees, this institution, which is capable of becoming, when wisely and intelligently administered, a mighty implement for the advancement of human welfare.

Dr. George Hubbard Clapp, president of the board of trustees of the university, delivered the speech of acceptance. He expressed appreciation of the gift and understanding of the importance of the work for which the building has been erected.

The final ceremony of the exercises was the conferring of fifteen honorary degrees, as follows:

Doctor of Laws

Edward Williams Morley, honorary president of the Eighth International Congress of Applied Chemistry.

John Ulric Nef, head of the department of chemistry of the University of Chicago.

Arthur Amos Noyes, professor of theoretical chemistry and director of the Research Laboratory of Physical Chemistry, Massachusetts Institute of Technology.

Rossiter Worthington Raymond, secretary emeritus of the American Institute of Mining Engineers.

Ira Remsen, former president and professor emeritus of chemistry, Johns Hopkins University.

Theodore William Richards, professor of chemistry and director of the Gibbs Memorial Laboratory, Harvard University.

Doctor of Science

John Jacob Abel, professor of pharmacology, Johns Hopkins University.

George Hubbard Clapp, president of the Pittsburgh Testing Laboratory and of the Board of Trustees of the University of Pittsburgh.

Elbert Henry Gary, chairman and chief executive officer of the United States Steel Corporation.

John Hays Hammond, consulting mining engineer.

Henry Marion Howe, former professor of metallurgy, Columbia University.

Doctor of Chemical Engineering

William Hultz Walker, professor of chemical engineering, Massachusetts Institute of Technology.

Milton C. Whitaker, professor of industrial and engineering chemistry, Columbia University.

Doctor of Chemistry

Charles Lathrop Parsons, chief mineral chemist, Bureau of Mines.

Edgar Fahs Smith, provost of the University of Pennsylvania.

Immediately after the close of the dedicatory exercises, the trustees, faculty and guests of the university met at a luncheon in the University Club. The remainder of the after-

noon was devoted to an inspection of the new building of the Mellon Institute.

The recipients of honorary degrees were the guests of the university at the annual alumni banquet held at the Schenley Hotel from 6:00 to 8:30 P.M. The speakers at this dinner were Dr. Raymond F. Bacon, director of the Mellon Institute, who responded to "The Mellon Institute"; Dr. Walther Riddle, who gave a historical sketch of the department of chemistry of the university; Hon. Elbert H. Gary, chairman of the United States Steel Corporation; Dr. Theodore William Richards, who spoke on "The Practical Use of Research in Pure Science" and extended Harvard's congratulations to Pittsburgh upon the acquisition of the Mellon Institute; and Chancellor Samuel Black McCormick, who completed the toast list with an eloquent response to "The University," in which he stated that the gift of the Mellon Institute had placed a great responsibility upon the University of Pittsburgh as well as having been a priceless acquisition; that the university was ready to meet the responsibility and, he felt sure, would show the donors and the country at large that it would make the most of the great benefaction.

Judge Gary's address was in part as follows:

In humankind there is an element which is interested in, if, indeed, it does not actually enjoy reading or listening to, adverse references to the character or conduct of an individual or association of individuals, and, by reason of this fact, agencies for the collection and distribution of unfavorable comments have become more or less popular. A questionable kind of success is often realized by the individual or the publication whose energies are devoted to frequent and furious personal attack against the standing or the action of others. These efforts sometimes take the form of individual work, investigations by committees or commissions created by the legislatures or congresses, or, in exceptional cases, even by judicial branches of government, such as grand juries, with their inquisitorial power. Oftentimes the investigators are not only utterly incompetent, but they are prejudiced and willfully repress many of the pertinent and material facts. They seek to produce for circulation and criticism only information calculated to bring reproach upon the persons involved in the inquiry. No one is exempt from these criticisms.

Circumstances seem to show that we are approaching the time when the investigator will be investigated; when the criticizer will be criticized; when committees and commissions will be brought before other similar bodies for judgment. It would be interesting to the public if it could be informed of the real motives which have prompted some of the official inquiries, and if it could learn of the unfair methods which have been sometimes pursued, and if it should know the amount of governmental funds which have been appropriated for the use of committees and how they have been disbursed; in fact, if some of those participating could be subjected to the same scrutiny which they have exercised.

The general attitude of the great newspapers of to-day is fair and just. They influence and are influenced by the general public. They reflect the general sentiment. This is most important in considering the future welfare of this country.

If the picture which I have drawn is a true one, then the course before us, which leads to prosperity, success and happiness, is plain and we will pursue it. We must conduct affairs in our charge with the expectation that we shall be criticized.

After the banquet, the new building of the Mellon Institute was thrown open for a reception of friends of the institute. The rooms of the main floor were used for the reception, although the entire building was open for inspection. On the evening of February 27, the first Mellon lecture was delivered by Professor John Jacob Abel, of Johns Hopkins University, in the assembly hall of the institute; Dr. Abel's subject was "Experimental and Chemical Studies of the Blood and Their Bearing on Medicine."

W. A. Hamor

The Mellon Institute of Industrial Research

CHARLES EDWIN BESSEY

The Botanical Society of Washington at its one hundred and third regular meeting, March 2, 1915, unanimously passed the following resolutions upon the death of Doctor Charles E. Bessey, dean and professor of botany at the University of Nebraska.

Whereas, In the recent death of Professor Charles E. Bessey, botany has lost one of its ablest investigators and teachers, one of the pioneers in

the introduction of the present laboratory methods of teaching biology, and

WHEREAS, He was widely known and highly respected by his fellow botanists, and beloved by his numerous students in whose welfare and success he took the keenest personal interest, and

WHEREAS, The death of such a man comes as a personal loss to all American botanists; therefore be it

Resolved, That the Botanical Society of Washington express its deep sense of regret and extend to his family its deepest sympathy in their great bereavement; be it further

Resolved, That a copy of these resolutions be spread upon the minutes of this society and sent to the immediate relatives of the deceased and to SCIENCE.

PERLEY SPAULDING,
Corresponding Secretary

SCIENTIFIC NOTES AND NEWS

THE annual general meeting of the American Philosophical Society will be held in the hall of the society at Philadelphia on April 22, 23 and 24, beginning at 2 P.M. on Thursday, April 22.

SIR J. J. THOMSON has been elected president of the Physical Society, London. Prince B. Galitzin has been made an honorary fellow of the society.

THE gold medal of the British Institution of Mining and Metallurgy has been awarded to Dr. Willet G. Miller, geologist of Ontario.

AT the meeting of the Royal Geographical Society on February 22, Mr. Page, the American ambassador, presented to Dr. Scott Keltie, secretary of the Royal Geographical Society, the Cullum gold medal, awarded to him by the American Geographical Society.

MR. JOHN S. LONGWELL, C.E. (Cornell, '10), of the Reclamation Service, has been awarded the prize given annually by the American Society of Civil Engineers for the best paper by a junior member of the society.

THE Samuel D. Gross prize of the Philadelphia Academy of Medicine for the year 1915 has been awarded to Dr. John Lawrence Yates, Milwaukee, for his essay entitled "Surgery in the Treatment of Hodgkin's Disease." The amount of this prize is $1,500.

MR. W. H. HOYT, C.E. '90, College of Engineering, University of Minnesota, assistant chief engineer of the D. M. N. Railroad, has been elected president of the Minnesota State Surveyors and Engineers Society.

THE Atlanta Neurological Society was organized February 11, with the following officers: *president*, Dr. E. Bates Block; *vice-president*, Dr. Hansell Crenshaw; *secretary*, Dr. Lewis M. Gaines. The society will hold its meetings on the second Thursday of each month.

THE *Journal* of the American Medical Association states that Dr. William J. Mayo, of Rochester, Minn., was the guest of honor at the Detroit Academy of Medicine on February 23. On February 22, Dr. Mayo was the principal speaker at foundation-day exercises of the department of medicine and surgery at the University of Michigan, Ann Arbor, and on February 24 the Kalamazoo Academy of Medicine gave a luncheon in honor of Dr. Mayo, after which he gave an address on "Some General Considerations which influence the Advisability of Surgical Treatment." Dr. Charles H. Mayo was the guest of honor at the twentieth annual banquet of the Kansas City Academy of Medicine, February 27. Dr. Jefferson D. Griffith presided and Dr. Mayo delivered an address on "Why Gastro-Enterostomy Fails to Cure."

THE Harvard University unit for service at the American Ambulance Hospital in Paris left on March 17, to serve until June 30. Members of the unit are: H. Cushing, '95, M.D., A.M., Moseley professor of surgery, as head surgeon; R. B. Greenough, '92, assistant professor of surgery, surgeon and executive officer; R. P. Strong, professor of tropical medicine, bacteriologist; R. B. Osgood, M.D., '99, instructor in orthopedics, orthopedic surgeon; B. Vincent, '98, assistant in surgery, assistant surgeon; W. M. Boothby, '02, lecturer in anesthesia, anesthetist; F. A. Coller, '12, M.D.; E. C. Cutler, '13, M.D.; P. D. Wilson, and M. N. Peterson, '14, M.D., resident surgeons; L. G. Barton, Jr., '12, M.D., surgical assistant; O. F. Rogers, Jr., '12, M.D., medical

assistant; G. Benet, '13, M.D., laboratory assistant; and Miss Edith I. Cox, Miss Geraldine K. Martin, Miss Helen Park and Miss Marion Wilson, operating nurses.

Dr. R. A. Reeves, professor of opthalmology in the University of Toronto, president of the British Medical Association for the meeting held in Toronto in 1906, has become professor emeritus.

Dr. B. H. A. Groth has resigned his position as plant physiologist in the department of botany of the New Jersey College experiment Station, to become director of the experiment station under the government of the Republic of Panama. After April 15 he will be in Panama City.

Dr. Karl Van Norden, formerly in the research department of John Hopkins Hospital, who has been an officer in the German army since the beginning of the war, was seriously wounded at the battle of Lodz but is now about to return to the front.

Dr. E. O. Hovey, of the American Museum of Natural History, has gone to the West Indies to continue the studies on the volcanoes of the Lesser Antilles, which he began some years ago when the great eruptions on the islands of Martinique and St. Vincent occurred. He will devote his time particularly to the Grande Soufrière of Guadeloupe, Mount Pelé of Martinique, the Soufrière of St. Vincent and the boiling lake of Dominica, collecting gases from the fumeroles and making temperature observations, and taking note of the changes which have occurred since his visit in 1908. The expedition is undertaken through the aid given to the museum by the Angelo Heilprin Exploration Fund established by Mr. and Mrs. Paul J. Sachs.

The departments of geology of Harvard University and Massachusetts Institute of Technology announce that Dr. Ralph Arnold will give a series of ten lectures on the "Geology of Petroleum." The first five lectures will be given from 4:30 to 5:30 p.m. on April 5, 6, 7, 8 and 9 in the geological department at Harvard. The last five lectures will be given from 4:30 to 5:30 p.m. on April 12, 13, 14, 15 and 16 in the geological department of the institute.

F. C. Langenberg, of Harvard University, and R. G. Webber, of Ohio University, Athens, Ohio, at the recent New York meeting of the American Institute of Mining Engineers read a paper on the Structure and Hysteresis Loss in Medium-Carbon Steel. It was illustrated by microphotographs of the physical structure, and curves of the hysteresis loss in a series of steels heat-treated to different temperatures.

Professor C. F. Shoop, of the Experimental Engineering Department of the College of Engineering of the University of Minnesota, recently read a paper before the Minnesota Society of Engineers and Surveyors in annual convention in St. Paul. The title of the paper was "The Abrasion Value of Various Concrete Aggregates in Concrete Roads."

A memorial tablet has been placed in the house at Cosenza, Italy, where the eminent alienist, B. Miraglia, was born, and a similar tablet is to be placed in the insane asylum at Aversa, the scene of his work, and a street in Aversa is to be named after him.

Miss Davy, niece of Sir Humphry Davy, has presented to the Royal Institution, London, a bust of the great chemist executed by Samuel Joseph in 1822.

Frank Asbury Sherman, professor of mathematics at Dartmouth College from 1871 until his retirement as professor emeritus in 1911, died on February 25 in his seventy-fourth year.

Sir George Turner, distinguished for his work on the rinderpest and on leprosy, died on March 12 at the age of sixty-four years from leprosy, contracted during research work to discover a cure for the disease.

Dr. E. von Esmarch, formerly director of the Kaiser Wilhelm Institute at Dresden, died on February 5, at the age of fifty-nine years.

Dr. Julius Arnold, professor of pathological anatomy at the University of Heidelberg, died on February 6, in his eightieth year.

The Washington Academy of Sciences held a joint meeting with the Biological Society

on March 11, in the Auditorium of the new National Museum, when there was a lecture by Mr. Wilfred H. Osgood, of the Field Museum of Natural History, who was engaged on a special investigation of the fur-seal question for the Department of Commerce during the summer of 1914. His subject was "Fur Seals and Other Animals on the Pribiloff Islands."

DIRECTOR JOHN F. HAYFORD, of the college of engineering, Northwestern University, addressed a group of graduate students and professors of the University of Wisconsin on the subject of "Isostasy" on March 1. That evening he addressed the Science Club of the same institution on the decision in regard to the Panama-Costa-Rico Boundary Dispute. Director Hayford was chairman of the committee appointed by the chief justice of the United States, which made a personal investigation and survey.

DR. LAFAYETTE B. MENDEL, professor of physiological chemistry in Yale University, addressed the Johns Hopkins Hospital Medical Society at Baltimore, March 1, on "Nutrition and Growth."

THE tenth lecture before the Harvey Society was given on March 13, at the New York Academy of Medicine, by Professor Elliott P. Joslin, of Harvard University, on "Carbohydrate Utilization in Diabetes, based upon Studies of the Respiration, Urine and Blood."

DR. CHARLES S. BERKEY, associate professor of geology in Columbia University, will give the last of the Jessup lectures on "Origin and Meaning of Some Fundamental Earth Structures" at the American Museum of Natural History on March 26. The subject of the lecture is "The Relation of Structural Geology to Practical Undertakings."

PROFESSOR EDWARD H. WILLIAMS, JR., of Woodstock, Vt., for many years head of the department of mining and geology at Lehigh and now a lecturer of the university, gave two lectures in February before the students. His subjects were "The Geology of the Lehigh Valley" and "The Formation of the Allegheny River."

THE American Association of Pathologists and Bacteriologists, of which Dr. Leo Loeb, St. Louis, is president, will meet in St. Louis, on April 2 and 3. The meetings will be held in the pathological department of Washington University Medical School and in the library of the St. Louis University. Preceding these meetings on April 1 will be held the annual meeting of the American Association for Cancer Research and the annual meeting of the International Association of Medical Museums. These meetings will be held in the laboratories of the Washington University Medical School.

THE seventh semi-annual meeting of the American Institute of Chemical Engineers will be held in San Francisco, Calif., from August 25 to 28. An itinerary is being arranged so that the natural scenery of the west may be seen and also some of the more important mining operations as well as the typical chemical industries of California.

THE senate of the Kaiser Wilhelm Society for the Advancement of Science at a session held on January 23, determined to break ground for the projected Kaiser Wilhelm Institute for Physiology and for the Study of the Brain. The Kaiser Wilhelm Institute for Biology is soon to be opened at Dahlem.

UNIVERSITY AND EDUCATIONAL NEWS

AT the convocation at the University of Chicago, on March 16, Julius Rosenwald Hall, devoted to the work of the departments of geology and geography, was dedicated. The building, a gift from Mr. Julius Rosenwald, a trustee of the university, has cost approximately $260,000.

THE Arnold Biological Laboratory, ground for which was broken at Brown University last summer, is practically completed and will be put into use for regular class work with the reopening of college after the spring recess. The building, which is three stories in height, 117 feet long and 52 feet wide, will cost when finished $80,000, and $30,000 more will be expended upon the equipment. The cost of the building will be covered by a bequest made to the university for the purpose by the late Dr.

Oliver H. Arnold, while the funds for equipment have been subscribed.

Professor Thomas S. Fiske has been designated as administrative head of the Columbia University department of mathematics for two years beginning July 1, in the place of Professor Cassius J. Keyser, who retires at his own request.

Mr. Morris M. Wells, of the University of Illinois, has been appointed instructor in the department of zoology in the University of Chicago.

The Benjamin Peirce instructorships in mathematics at Harvard University, the terms of whose establishment were recently announced in Science, have now been filled for the year 1915–16 by the appointment of Dr. Edward Kircher and Dr. George A. Pfeiffer.

DISCUSSION AND CORRESPONDENCE

THE FUNDAMENTAL EQUATION OF MECHANICS

To the Editor of Science: Professor Huntington's letter in Science of February 5 is an important contribution to the subject of the teaching of elementary dynamics, but the fact that he and Professor Hoskins are not in agreement on "the question whether $F = ma$ or $F/F' = A/A'$ is the better form in which to introduce the fundamental equation of mechanics" shows that something remains to be said on the subject. In my opinion neither of these equations ought to be considered as fundamental, for both are derived from more elementary equations.

Professor Huntington objects to $F = ma$ for certain reasons. He might have made other objections to it: for example, the equation is not true in the ordinary English system (foot-pound-second) until it is hybridized by valuing either F or m in some other unit than pounds (poundal or gee-pound) or a in "gravitals" (instead of feet) per second per second (1 gravital = 32.174 feet),[1] or else the letter m is explained as not being quantity of matter in pounds, but only the quotient or ratio W/g. Neither is it true in the metric kilogram-meter-second system. (I do not think the metric people have yet tried to introduce a "kilogrammal" or a "gee-kilogram.") It is of course true in the dyne-centimeter-gramme-second system, but this system is only used in higher physical theory, and it should not be inflicted on young students. The equation $F = ma$ is, however, a handy equation to work with when it is understood that m is merely a conventional symbol for W/g.

The equation $F/F' = A/A'$ may be useful for some purposes, but I agree with Professor Hoskins in not accepting it as fundamental or as the best equation to be used as an introduction of the subject. Each of the equations being open to objection, I wish that both Professor Hoskins and Professor Huntington would consider the following treatment of the subject, and let me know what objections there are to it.

Quoting Professor Huntington's words: "The first serious problem which confronts the teacher of dynamics is the problem of making the student understand the effect which a force produces when it acts on a material particle" (I would substitute the word "body" for material particle).

Let us start with the student just out of the grammar school, who has never studied physics, but who understands the simplest forms of algebraic equations, and how to make $a = F/m$ out of $F = ma$. He already knows the ordinary meaning of the words time, space, force, matter (or stuff, solid, liquid or gas). He may be told that the word "body" means a piece or chunk of stuff, and that velocity is just another name for speed. He knows that force may be measured by a spring balance, and that the quantity of matter in a body may be determined by weighing it on grocer's even-balance scale or on a platform

[1] The writer invented the "gravital" and also the "timal" (=1/32.2 of a second) over 20 years ago as antidotes to the "poundal," merely to serve as "horrible examples" of what might be done in the way of introducing still further confusion into our systems of units. He also invented the "massal" = 32.2 pounds, but that has got into some text-books disguised under the names of "gee-pound," slug, and "engineers unit of mass." The latter term is especially objectionable, for it has never been used by engineers.

scale; provided it is weighed at any place other than the imaginary "point of zero gravity."

The fundamental problem to be considered by the student is: Given a constant force F lbs. acting for T seconds on a quantity of matter W lbs., at rest at the beginning of the time, but free to move, what are the results, assuming that there is no frictional resistance?

The first result, which is already known by the boy, is motion, at a gradually increasing velocity. What the relation is between the elapsed time and the velocity may be determined by experiment. He may take a moving picture, with 50 films per second, of a body falling alongside of a rod marked with feet and inches. He may tow a boat having a load of 1,000 lbs. with a force of say 1 lb., exerted through a string and measured by a spring balance, alongside of a tow path on which a tape line is stretched; or there may be an Atwood machine in the high school on which experiments may be made. By these experiments he will learn the fundamental facts of dynamics and establish the fundamental equation. The facts are that the velocity varies directly as the time and as the force, and inversely as the quantity of matter, and the equation is $V \propto FT/W$ or $V = KFT/W$, K being a constant whose value is approximately 32, provided V is in feet per second, F and W in pounds and T in seconds.

The accurate determination of K requires the most refined experiments, involving precise measurements of both F and W, and of S, the distance traversed during the time T, from which V is determined, and precautions to eliminate resistance due to friction of air or water or of the machine used in the experiments. When these refined experiments have been made it has been found that the value of K is 32.1740, and this figure is twice the number of feet that the body would fall *in vacuo* in one second at or near latitude 45° at the sea level. It is commonly represented by g, or by g_0, to distinguish it from other values of g that may be obtained by experiments on falling bodies (or on pendulums) at other latitudes and elevations. The fundamental equation then is

$$V = FTg/W \qquad (1)$$

The velocity V is a derived quantity, derived from measurements of space (or distance) and time. If a body is moving at a uniform speed, such as the minute hand of a watch, V is a constant, and the distance varies directly as the time, and is the product of the velocity and the time, $S = VT$. But if the velocity varies directly as the time (uniformly accelerated motion), as in the case of the problem we are considering, then the distance is the product of the mean velocity and the time. Since in our problem the body starts from rest when the velocity is 0, and the velocity is V at the end of the time T, the mean velocity is $\frac{1}{2}V$ and the distance is $\frac{1}{2}VT$, whence $V = 2S/T$ and $T = 2S/V$.

The velocity V in feet per second, at the end of the time T is numerically equal to the number of feet the body would travel in one second after the expiration of the time T if the force had then ceased to act and the body continued to move at a uniform velocity.

The fundamental equation might be written $2S/T = FTg/W$, which is equivalent to $S = FT^2g/2W$, but as this is somewhat more cumbersome than the simpler-looking equation $V = FTg/W$, this latter equation is more convenient as the fundamental equation. It expresses the facts that the velocity varies directly as F and T and inversely as W, and that the velocity equals the product of F, T and g divided by W. Let us further consider the two equations $V = FTg/W$ (1) and $S = FTg/2W$ (2).

We have dealt with four elementary quantities F, T, S, W, one derived quantity V, and one constant figure 32.1740. It is understood that F is measured in standard pounds of force, the standard pound of force being the force that gravity exerts on a pound of matter at the standard location where $g = 32.1740$.

Each equation contains four variables V, F, T, W, or S, F, T, W, and in either equation if values be given to any three out of the four the fourth may be found. By ordinary algebraic transposition, or by giving new symbols to the product or quotient of two of the variables, many different equations may be derived from them, some of which are more curious than

useful. It is well not to give the student too many of them or he will become confused.

Here are some conclusions that may be derived from the equations, (1) and (2).

From (1), let $F=W$, the case of a body falling at latitude 45° at the sea level; then $V=gT$. If T also $=1$, then $V=g$, that is the velocity at the end of 1 second is g.

In the equation $V=gT$ substitute for T its value $2S/V$ and we have $V=2gS/V$, whence $V^2=2gS$. In the case of falling bodies, the height of fall H is usually substituted for S, and we obtain $V=\sqrt{2gH}$ (3).

Equation (2) with $F=W$ gives $V=\frac{1}{2}gT^2$.

From (1), by transposition we may obtain $FT=W\times V/g$ (4). The product FT is sometimes called impulse, and to the expression $W\times V/g$ is given the term momentum. It is usually written W/gV, but there is no reason why, except that it is customary, and it has been found convenient to use the letter M instead of W/g, so that the equation becomes

$$FT = MV \qquad (5)$$

Impulse = Momentum

In (4) we may substitute for T its value in terms of S and V above given, viz., $T=2S/V$ and obtain $F2S/V=MV$; whence $FS=\frac{1}{2}MV^2$ (6). The product FS is called work, and the expression $\frac{1}{2}MV^2$ kinetic energy, whence work expended = kinetic energy.

Acceleration.—The quotient V/T is called the acceleration. It may be defined at the rate of increase of velocity, the word rate, unless otherwise stated, always meaning the rate with respect to time, or "time-rate." In the problem under consideration, the action of a force in a body free to move, with no retardation by friction, the acceleration is a constant, $V/T=A$. The quantity g is commonly called the acceleration due to gravity, but it also may be considered either as an abstract figure, the constant g in equation (1), or as the velocity acquired at the end of 1 second by a falling body, or as the distance a body would travel in 1 second at that same velocity if the force ceased to act and the velocity remained constant.

Equation (6) then may be written

$$F=MA \qquad (7)$$

Force = M times the acceleration.

If a given particle [body] is acted on at two different times by two forces F and F', and if A and A' are the corresponding accelerations, then $\frac{F=MA}{F'=MA'}$ whence $F/F'=A/A'$. (8)

Equation (7) is called the fundamental equation by Professor Hoskins, while equation (8) is called fundamental by Professor Huntington, but it is shown above that they are derived from the more fundamental equation $V=FTg/W$.

Summary.—Take equation (1), $V=FTg/W$ (1). Substitute $2S/T$ for V, $S=FT^2g/2W$ (2).

Take $F=W$, then $S=\frac{1}{2}gT^2$,

and $V=\sqrt{2gH}$ (3)

From (1) by transposition $FT=WV/g$ (4)

Substitute M for W/g, $FT=MV$ (5).

In (5) substitute $2S/V$ for T,

$$FS=\tfrac{1}{2}MV^2 \qquad (6)$$

In (5) substitute A for V/T, $F=MA$ (7)

Apply (7) to the case of two forces acting at different times on the same body

$$F/F'=A/A' \qquad (8)$$

In this treatment the ambiguous words "weight" and "mass" have purposely been omitted.

If there is any easier way of "making the student understand the effect which a force produces when it acts on a material particle" than to have him study the above discussion and solve examples by its aid, it is very important that it should be found and incorporated in the text-books.

WM. KENT

A COURSE IN AGRICULTURE FOR NON-TECHNICAL COLLEGES

THAT there is an interest in agriculture as a subject of study in colleges or higher institutions in addition to that met by the state agricultural colleges, is manifested by the introduction a few years ago into the curriculum, in certain institutions (*e. g.*, Syracuse and Miami Universities) of several subjects associated with the work of the land-grant colleges. Further evidence is shown in the

preparation by one of the professors of a text on agricultural education which is regarded as well toward the head of the list upon that subject. But there seems to be still a field for educational work in agriculture, apparently not touched by any of the current courses, by which the subject matter of botany, zoology, geology and meteorology can be correlated with history through the common ground of agriculture.

The recent article upon agricultural botany, by Dr. Copeland, in SCIENCE, September 18, has suggested some details of such possible correlation in addition to a general plan already in mind. The scope of the course in mind is just the reverse of the work as ordinarily catalogued as a "Course in Agriculture" in the state colleges. Such courses take the general subject, agriculture, and divide it into its component parts, assigning portions to agronomy, to horticulture, to animal husbandry, soils, farm management and the other familiar departments. The other plan would take the work in the botanical laboratory and would show where it is of common application in the regular work of the farm; and in zoology, why the domestic animals are so useful to man through their anatomy and physiology, in place of merely noting their places as mammals in taxonomic scheme. It would show that the development of the technique of agriculture has been the companion, if not the guide, to advancing civilization through ethnology and anthropology to modern history, commercial and industrial.

This is an ambitious aim and would require much careful selection of material, before it could be regarded as definitely outlined. The final form would be an adjustment of the ideas of several rather than the dictum of an individual, as has been the case with college-entrance requirements in the sciences, although no official sanction, outside the several institutions which might offer the course, would be called for. As here outlined, the principal work of the course would be cared for by the regular staff of instructors in botany, zoology, geology, etc., the specialists in agronomy, livestock or soils being left with their respective subjects in the technical school. Under such regular teachers, however, those details in their course which relate to agriculture in any manner are to be brought out and made the peg upon which to hang the several facts of structure, behavior or adaptation observed.

The field as a whole may be divided into four sections, as follows:

1. *Soil.*—The basis of agricultural activity. Origin of soils; types of soil; properties of different soils; soil biology; soil management.

2. *Plants.*—The factory of agricultural products. Seeds; growth; nutrition; reproduction; weeds and diseases; phytogeography; agricultural ecology.

3. *Animals.*—The product of agricultural factory. Nutrition; anatomy; physiology; breeds; uses; predacious and beneficial species.

4. *Man.*—The controlling factor in agriculture. Races, civilization, colonization; commerce; rural and urban; raw materials and manufactures.

In attempting to assign to these topics their places in the four-year course, it must be remembered that it is not practical agriculture, but fundamental agriculture, that is in mind; it is not an attempt to make farmers, but to show how the farmer gets the results he does from certain methods of procedure, and why he is using those methods instead of some others, in a historical and economic, rather than technical and special study. Thus under the subject of soils, the danger of severe washing of fall-plowed fields in the south would be contrasted with the beneficial effects of the frost work on similarly treated fields in the colder states. Through the aid of the departments or instructors in bacteriology and mycology, relation between soil bacteria, root-infesting fungi and other organisms could be shown as scientific reasons behind the observed benefits of crop rotation, thus connecting the work on soils with that on crop plants. In the consideration of plants, the fact that upon green plants all animal life depends is the keynote, with details added discussing the parts of such plants utilized in particular cases, thus connecting directly with the study of those animals which make direct use of plant tissues for food. Under animals, the adaptation of the teeth to hard-stemmed forage

plants and the ease with which such crops are raised, should be brought out as important details in the usefulness of horses and cattle, as well as their anatomical adaptation to the work of pulling or carrying loads, and their physiological adaptations for meat and milk production.

The treatment of man as outlined would involve as much of the advanced sciences of anthropology and ethnology as one had time for; would naturally involve ancient history, in connection with grain commerce of Rome and her colonies; would take up the development of agricultural communities through the feudal system to the modern village of tenant farmers, and the rise of the freeholders, especially in the new settlements. The relation of established feast days (*e. g.*, Feast of First Fruits) of the ancient tribes, to events of the agricultural year would introduce the religious side of man, and the importance of conserving the produce of his labor, would serve to connect the ideas of property, ownership, wealth, capital and law.

The simpler relations would naturally be assigned to the earlier years of the course. Thus the subjects relating to plant life, in their fundamental details could be given in the sophomore year, supplementing the freshman work in botany; some work would likely be well retained to a later period. Soil work should follow the first year's work in chemistry and in physics, as the general properties of soils are in accordance with the principles learned in those subjects. The study of animals in relation to agriculture would be a good junior subject, as the additional year of work would make it the easier for the student to follow the course, and to grasp the essential points of structure, behavior, conditions of existence among wild and domestic animals, and similar details after he has had the less complex relationships among plants brought out in the sophomore work.

The study of the relation of man to agriculture, as suggested, should come in the senior year, in order that the work in history, economics, engineering and science may be available for use to aid in the development of the course by each man in the class bringing to it as broad a basis of work as possible. The topics introduced at this stage might easily serve as the basis of further study by the few specially interested along the lines of colonial, economic or industrial development. Frequent assignments of readings would be necessary, as the material is scattered and must be brought together under the new viewpoint.

Some suggestions have been found in several text-books on agriculture, agricultural education, farm management and similar topics, more or less along the lines here suggested, but in most cases, the discussion was from the standpoint of technical agriculture, as would be expected. Particular chapters could, however, be selected from a number of such books, to be used as collateral reading by either of the four college classes, suitably supplemented by lectures presenting the desired viewpoint, and developing the central theme. This may be briefly stated as follows: Agriculture as the oldest industrial occupation of man is the basis of all his later achievements, and supports him in his highest attainments. The course might be designated as one in "The development and scope of agriculture" and could be a lecture course supplemented by specified laboratory and class work in the several departments involved. The course might also be developed as a series of short courses, something on the plan of the "summer school" work, correlated by a carefully prepared syllabus or outline, each teacher selecting those phases of the work most closely related to agriculture in its broadest sense, and emphasizing the relation of his subject to the general topic.

Frederick H. Blodgett

SCIENTIFIC BOOKS

Psychology: General and Applied. By Hugo Münsterberg. New York and London, Appleton, 1914. Pp. xiv + 487.

Professor Münsterberg's latest work breaks away from the traditional presentation of psychology in many respects. The most novel features are the author's treatment of mental data from the teleological standpoint and the

emphasis which he lays on applied psychology. Each of these aspects of the subject is developed at considerable length.

The main body of the work is devoted to scientific psychology; but even here the treatment is out of the ordinary. We miss the usual detailed description of the nervous system and end organs. The author expresses his conviction in the preface that details from accessory sciences such as anatomy do not belong in an outline work on psychology. On the other hand, he believes that psychology should embrace social as well as individual phenomena, and accordingly several chapters are devoted to an examination of mental processes in the social group. Professor Münsterberg does not venture into the field of animal psychology, but he gives considerable prominence to "behavior" in the human sphere. In this connection he points out that tools are human extensions of the motor end-organs, while language is a highly specialized motor function, comparable however with other forms of motor activity.

After defining the scope of psychology in two opening chapters, the author proceeds to the scientific description and explanation of mental events. This aspect of the subject he terms *causal* psychology, to distinguish it from the purposive treatment which follows. More than half of the volume is devoted to the causal presentation, which for most writers constitutes the whole of scientific psychology. This part of the work is exceptionally clear and readable. One is reminded of the author's late colleague, William James, whose interesting style and picturesque illustrations add much to the value of his classic text.

It is to be regretted that Professor Münsterberg has not imitated his predecessor's fullness of treatment as well. In endeavoring to compress his material within too narrow limits he is compelled to curtail the discussion of certain topics unduly. For example, one would desire a more exhaustive examination of imagery, discrimination, abstraction and reasoning than the volume supplies. In this part of the work the author insists on a thoroughgoing scientific procedure. His psychological analysis rests on a rigid psychophysical basis and he aims at a complete mechanistic explanation of mental phenomena through the physiological processes which accompany them.

Professor Münsterberg classifies the elementary psychophysical processes under four heads: stimulation, association, reaction and inhibition; the complex processes include perception, ideas, activity, inner states and personality. A striking feature here is the grouping of actions, attention and thought processes together under the head of *activity*. Inner states are divided into simple feelings of pleasure and displeasure, emotions, and esthetic and intellectual attitudes.

The transition from individual to group processes is made through the study of race, sex, age and individual differences. It may be questioned whether such variations do not belong more properly to comparative than to social psychology; but as the author points out, the differences among individuals facilitate their grouping into social unity. The social grouping itself depends upon three elementary processes: union, submission and aggression. These factors work together and result in the complex social processes of organization and achievement.

The second part of the work is devoted to purposive psychology. Here the object is not to describe the inner life, but to understand its meaning. By a curious *volte-face* the author discards the scientific explanation of mental phenomena which he has hitherto insisted upon rigorously, and considers only their teleological bearings. Psychology regarded from this standpoint is "entirely removed from the world of describable objects and understood as an account of those functions in the personality which point beyond themselves and are felt as deeds of the subject" (46). In connection with this change to the subjective standpoint Professor Münsterberg renames the facts themselves. Instead of psychical elements we have experiences; instead of perception we have immediate reality; ideas become meaning, activity becomes the will.

It is somewhat difficult to grasp the significance of this transformation. Granting that a plexus of ideational elements may be called

meaning, and that a certain plexus of activities constitutes *will,* the scientist may still question the propriety of abandoning the associational basis of meaning or ignoring the causal sequence of volitional acts, as Professor Münsterberg appears to do.

In other sciences the speculative hypotheses which have stood the test of criticism have been attempts to amplify or reconstruct the principles discovered by the science itself, rather than to deny its fundamental generalizations. Professor Münsterberg's reconstruction of psychology, on the contrary, starts out by repudiating the generalizations based on observed temporal sequences, and assuming that the acts of our inner life are not contained in time (301), that "our mental life is free" (296).

It would appear that the author makes altogether too crucial a distinction between *cause* and *purpose.* His interpretation of both terms is open to challenge. The analysis of the *purpose* concept has never been fully carried out, but at least we know that "prevision" and "activity toward an end" admit of biological interpretation in harmony with mechanistic principles. As for causality, the author's use of the concept is not in harmony with Hume's classic analysis, which demonstrated that "necessary" connection is not an essential feature of the causal sequence.

Science to-day generally accepts Hume's conclusions. The chemist and physicist regard the laws of their sciences as merely generalized statements of observed facts. They distinctly refuse to commit themselves as to whether causal sequences *must* be as they actually are. Since Darwin's time most biologists have interpreted the evolution of species and the stages of individual development in the same way. Scientific explanation at the present day does not seek to impose anthropomorphic compulsions upon nature. Nature has been found to be self-consistent in the past; the scientist assumes that the same self-consistency will be observed in the future. The generalized notion of uniformity and self-consistency is all that is implied in the scientific conception of *law.*

Professor Münsterberg interprets the term "law" as involving a "necessary connection" between phenomena. For example, if we have met a man and heard his name, "the law of association makes it necessary that if we meet the man again his name comes to our mind" (22). The author states specifically that "the scientist has a right to claim that all his laws are meant as expressions of causal necessity" (31). Yet this necessary connection is just what most physical scientists plainly disavow. They aim merely to generalize the uniformities of sequence observed in nature.

In any science it is quite legitimate to suggest a working hypothesis which goes beyond the facts and reconstructs them. The electron theory and Mendeleeff's periodic law are such reconstructions of physical and chemical data. So in psychology Professor Münsterberg may find grounds for his theory of "self as a system of purposes." But such a theory should be based on scientific foundations. Instead of two standpoints, the causal and purposive, we should have systematic description of mental phenomena and a suggested reconstruction; the latter should amplify the empirical laws, instead of rejecting them.

The author's attempt to formulate a system of psychology from the teleological standpoint will not appeal to the plain empirical psychologist, because it runs counter to the scientific development of the subject. It transcends the scientific limitations of both cause and purpose. "Necessity" is an anthropomorphic addition to causality. Failing to find any such necessary connection between mental events, the author throws his science to the winds and bases his teleological reconstruction on an equally anthropomorphic interpretation of purpose. The result is perplexing. It is not easy to attach a definite meaning to such statements as "the free act is free because it has no causes" (324). Nor can we take a definite attitude toward the assertion that "we can not imagine a purposive act the meaning of which is not a negation of an opposite purpose" (316).

In the third part of the volume Professor Münsterberg returns to more familiar terri-

tory and discusses the applications of psychology to science and art. He indicates the line of demarcation between psychology and the human sciences as follows: The understanding of mental operations is valuable in the study of history, sociology, etc., but the interpretation of the subject-matter in each case belongs to the special science and not to psychology. In his closing chapters the author considers the applications of psychological data and methods to education, law, economics, medicine and culture. To this applied field he gives the name psychotechnics. These chapters offer a most interesting presentation of the recent progress in applied psychology, a line of development which seems likely to bring about a closer connection between psychology and the professions.

Whether or not the reader agrees with Professor Münsterberg's fundamental positions, he will find the present work most stimulating and suggestive.

HOWARD C. WARREN

PRINCETON UNIVERSITY

Design of Polyphase Generators and Motors. By HENRY M. HOBART. McGraw-Hill Book Company.

In "Design of Polyphase Generators and Motors," Mr. Hobart takes up the design of a simple three-phase generator and an induction motor from the standpoint of a designing engineer. This occupies the major portion of the book, but there are in addition two chapters devoted to a comparison of synchronous motors and induction motors and to the induction generator. Much useful information and many valuable tables compiled from empirical data obtained from existing machines are included.

The book follows the plan, outlined by the author in its preface, of taking up immediately without any preliminary discussion the design of a three-phase generator of definite rating, introducing the principles involved when required as the design progresses. In addition to the design of a three-phase generator, the design of a polyphase induction motor is also considered. The book should be valuable to the young designer who has a fair knowledge of the principles underlying operation and design of electrical machinery.

It is to be regretted that a portion of the book is not devoted to a simple analytical study of the effect on the operating characteristics of machines of modifying their dimensions and windings in order that the young designer might learn to analyze existing designs and to be able to judge the fitness of any particular design for a definite class of service.

Two appendices give a full bibliography of the papers dealing with polyphase generators and motors which have been printed in the *Proceedings* of the American Institute of Electrical Engineers and in the *Journal* of the British Institute of Electrical Engineers.

RALPH R. LAWRENCE

Synchronous Motors and Converters. By ANDRÉ BLONDEL. Translated from the French by C. O. MAILLOUX. McGraw Hill Book Co. 1913.

"Synchronous Motors and Converters" is a translation of the admirable little book by André Blondel entitled "Moteurs Synchrone à Currents Alternatifs." Several chapters have been added to the translation in order to increase the scope of the book and to bring it up to date. The translation is divided into three parts. Part I. is a translation of the original book with one chapter added by Professor C. A. Adams, of Harvard University. Part II. relates to Rotary Converters and is made of new material by Professor Blondel and a translation of papers presented by him at the Paris Congress in 1900. Professor Adams has also added a chapter to this section relating to the split-pole converter. Part III. contains reprints of papers presented by Professor Blondel at the St. Louis Electrical Congress in 1904, relating to his "two reaction" method of treating the armature reaction of alternators.

The first part of the book takes up the general principles of synchronous motors and a study of their operation under different conditions, and is particularly valuable in giving the development of well-known Blondel bi-

polar circle diagram. In translating Professor Blondel's "Moteurs Synchrone," Mr. Mailloux has rendered a valuable service to English-speaking electrical engineers.

RALPH R. LAWRENCE

Storage Batteries. By HARRY W. MORSE. New York, The Macmillan Company. 1912.

This little book of 263 pages on storage batteries is based upon lectures given by Professor Morse at Harvard University. It deals only with the theory and the characteristics of storage batteries. No attempt is made to discuss problems connected with storage-battery engineering. The first chapters are devoted to the laws underlying the action of storage cells and to the consideration of the fundamental reactions. A short discussion of the ionic theory and the energy relations involved in the action of a storage cell is included. Later chapters are given up to the operating characteristics, efficiency and capacity, and to the general principles underlying the methods of forming modern storage battery plates. The diseases and care of storage batteries are also discussed. In the last chapter a few pages are devoted to the iron-nickel-alkali cell. "Storage Batteries" is an excellent little book for any one who wishes a simple treatment of the theory, action and care of lead-lead-peroxide storage batteries.

RALPH R. LAWRENCE

SPECIAL ARTICLES

CORRELATION BETWEEN EGG-LAYING ACTIVITY AND YELLOW PIGMENT IN THE DOMESTIC FOWL[1]

IN the Leghorns and the so-called American breeds, such as the Plymouth Rocks, yellow, in the form of yellow fat,[2] is present in varying amounts in the legs and beak. In these breeds, individual birds may undergo considerable change in the amount of the yellow pigment visible. The paling or yellowing of the legs has been attributed by poultrymen to various environmental factors. Of recent years, some individual poultrymen, however, have claimed that paling of the legs is due to heavy laying.[3] The requirements of the "Standard of Perfection," which controls judges in the show room, as well as the common practise of poultry breeders, are opposed to a belief in any connection between laying and leg color. Woods[4] under the title, "Has Leg Color Value Indicating Layers?" in the most recent discussion of the subject, concludes:

> Personally we believe that, as a practical guide in the selection of heavy layers, . . . the leg color of itself has no real value.

So far as the writers are aware, no published data are available which show in how far the leg color may be of any value in selecting the laying hen, and such suggestions as have been made in this connection have confined themselves almost entirely to a consideration of the legs alone. The results tabulated in the present paper show conclusively, it is believed, that a close connection does in fact exist between the yellow pigmentation in a hen and her previous egg-laying activity, and that, in Leghorns, the color of the ear-lobes is perhaps a better criterion of laying activity than either legs or beak and is more readily recorded.

The hens investigated were in the egg-laying contest at Storrs, Conn., and were handled essentially alike. The influence of environmental factors, therefore, can be largely neglected. The amount of yellow was measured by means of the Milton Bradley color top, which, when spinning, acts as a color mixer. The top readings were taken of the White Leghorns listed in Tables I. and II. at three different periods in October.

In Table I., the records at the three different readings have been used. A bird laying on the day of record, or on a later day within the month is considered to be laying and credited

[1] Paper presented before the American Society of Naturalists, Philadelphia, December 31, 1914.

[2] Barrows, H. R., "Histological Basis of Shank Colors in Domestic Fowl," Bull. 232, Maine Agric. Exper. Station, 1914.

[3] Rice, J. E., Circular 11, p. 42, N. Y. State Dept. of Agriculture, 1910; Barron, Tom, *Connecticut Farmer*, September 12, 1914; Circular 499, Maine Agric. Exper. Station. This is listed as an abstract of Bull. 232.

[4] Woods, P. T., *Amer. Poultry Jour.*, p. 35, January, 1915.

TABLE I

Percentage of Hens Laying and Average Number of Days since Laying for Different Amounts of Yellow in Ear-lobes

Per Cent. Yellow	5–10	11–15	16–20	21–25	26–30	31–35	36–40	41–45	46–50	51–55	56–60	61–65	66–70	71–75
No. records	41	125	80	67	62	92	94	94	108	84	44	28	9	4
Av. days since laying	0.4	1.6	7.3	17.1	26.2	37.9	41.5	44.0	45.1	51.3	55.9	61.4	50.3	71.0
No. records = laying	36	98	44	17	3	0	1	0	2	0	0	0	0	0
Per cent. records = laying	87.8	78.4	55.0	25.4	04.8	0	01.0	0	01.9	0	0	0	0	0

White Leghorns. Total number of records, 932; total number of birds, 317

with a zero. If she laid on the day before the record but not later, she is credited with one "day since laying" and in a similar way a longer period of inactivity in laying is indicated by a larger number of days since laying. With the exception of a few cases where this is not possible three records were taken of each bird. Since October is the season of decreasing egg production, the majority of the birds increased their quantum of yellow and consequently most birds are listed in more than a single color grade. Beginning with the 41 records in the 5–10 per cent. color grade, which show an average of only 0.4 days since laying, the number of days increases consistently with the amount of yellow in the ear-lobes. The percentage of records that indicate actual laying drops rapidly from 87.8 per cent. for 5–10 per cent. yellow to zero for grades of yellow above 30 per cent. The three cases of laying among records above 30 per cent. yellow were for sporadic layers. The table shows that it is practically certain that a bird with an ear-lobe showing more than 30 per cent. yellow at the time of the records is not in a laying condition.

Table II. shows the percentage of yellow in the ear-lobes of 312 birds according to the color records of October 20, together with egg records for the different color groups. It will be seen that in general as the percentage of yellow increases the egg production falls off, and that the correlation is most marked during the periods nearest the time when the records were taken. A distinct correlation with color seems to show in the yearly averages but is largely an indirect one. It is generally only the best birds—those that make the large yearly records—that are laying in October. Therefore, any method that selects the laying birds at this season will select at the same time the birds laying above average throughout the year, and consequently give high yearly totals. It will be observed that 30 per cent. seems to be a critical amount of yellow. Above this amount comes the sudden drop in egg production for the months of September and October and also above 30 per cent. yellow the yearly totals fall to between 130 and 140 with but slight change thereafter.

TABLE II

Average Egg Records for Different Amounts of Yellow in Ear-lobes of 312 White Leghorns

Per Cent. Yellow	5–10	11–15	16–20	21–25	26–30	31–35	36–40	41–45	46–50	51–55	56–60	61–65	66–70	71–75
No. birds	7	36	40	16	20	31	33	41	39	30	13	4	1	1
September	19.7	18.2	16.9	16.4	10.3	5.5	6.1	4.9	4.0	3.6	2.4	1.3	0.0	0.0
October	15.3	14.2	11.7	8.1	3.2	0.5	0.2	0.2	0.2	0.1	0.0	0.3	0.0	0.0
Year	197.1	187.9	184.3	164.3	148.5	139.1	139.6	134.2	138.2	137.8	124.7	100.8	70.0	83.0

By the use of beak and leg color, similar results to those shown in Tables I. and II. have been worked out for other breeds than Leghorns and more complete data are being published elsewhere.

The data presented indicate a connection between the amount of yellow pigment showing in a hen and her previous laying activity. The most natural assumption is that laying removes yellow pigment with the yolks more

rapidly than it can be replaced by the normal metabolism, and in consequence, the ear-lobes, the beak and the legs become pale by this subtraction of pigment.

A. F. Blakeslee,
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Connecticut Agricultural College,
Storrs, Conn.

PROCEEDINGS OF THE ANNUAL MEETING OF THE AMERICAN SOCIETY OF ZOOLOGISTS HELD IN PHILADELPHIA 1914

The American Society of Zoologists, in conjunction with the American Society of Naturalists and Section F of the American Association for the Advancement of Science, held its twelfth annual meeting (the twenty-fifth annual meeting of the society since its establishment as the American Morphological Society) in the zoological laboratory of the University of Pennsylvania, Philadelphia, Pennsylvania, on December 29 and 30, 1914.

At the session for transacting business, held on the afternoon of December 30, the following officers for the society were elected for the year 1915:

President—William A. Locy, Northwestern University, Evanston, Ill.

Vice-president—William E. Ritter, Scripps Institution, La Jolla, Cal.

Member at large of the Executive Committee—D. H. Tennent, Bryn Mawr College, Bryn Mawr, Pa.

Upon the recommendation of the executive committee the following persons were elected to membership in the society:

Cora J. Beckwith, assistant professor of zoology, Vassar College; Ralph V. Chamberlain, museum of comparative anatomy, Harvard University; Margaret H. Cook, instructor in zoology, Wellesley College; J. A. Detlefsen, assistant professor of genetics, University of Illinois; Howard E. Enders, associate professor of zoology, Purdue University; Nathan Fasten, instructor in zoology, University of Washington; Richard B. Goldschmidt, in charge of department of genetics, Kaiser Wilhelm Institut für Biologie, Berlin (Yale University); Joseph Grinnell, director, museum of vertebrate zoology, University of California; Carl G. Hartman, adjunct professor of zoology, University of Texas; Mildred A. Hoge, instructor in zoology, Indiana University; A. G. Huntsman, lecturer in biology, University of Toronto; B. F. Kingsbury, professor of histology and embryology, Cornell University; F. H. Krecker, assistant professor of zoology, Ohio State University; K. S. Lashley, Adam T. Bruce Fellow, Johns Hopkins University; W. H. Longley, professor of botany, Goucher College; Elmer J. Lund, instructor in zoology, University of Pennsylvania; Roy L. Moodie, instructor in anatomy, University of Illinois; Julia E. Moody, instructor in zoology, Wellesley College; Anna H. Morgan, associate professor of zoology, Mount Holyoke College; T. S. Painter, instructor in biology, Yale University; B. M. Patten, instructor in histology and embryology, Western Reserve Medical School; B. H. Ransom, chief, zoological division, Bureau of Animal Industry, Washington, D. C.; E. E. Reinke, instructor in zoology, Rice Institute, Houston, Texas; Lucy W. Smith, instructor in zoology, Mount Holyoke College; A. H. Sturtevant, Cutting Fellow, Columbia University; Shiro Tashiro, instructor in physiological chemistry, University of Chicago; Ernest I. Werber, assistant in biology, Princeton University; Paul S. Welch, assistant professor of entomology, Kansas State Agricultural College.

The secretary-treasurer of the society was authorized to prepare and print a list of the names, addresses, etc., of the members and officers elected at this meeting and any corrections or additions needed to be made to the published list of members, and to distribute copies of the same to all members. He was also instructed to secure and distribute to members reprints of the proceedings of the Philadelphia meetings when the same shall have been published in Science.

The committee on premedical education, appointed at the last annual meeting, submitted no report and it was continued with instructions to report at the annual meeting in 1915.

The executive committee, to which the "Matthews Plan for the Organization of an American Biological Society" was referred last year for consideration and report to a future meeting, asked and was granted more time for this work.

The question of holding a mid-year meeting of the society, as a whole, in San Francisco in connection with the Panama Exposition was considered and, upon motion by Professor R. G. Harrison, the society took the following action: "The American Society of Zoologists urges its members who reside on the Pacific coast to form a section of the society, such as is provided for by the constitution, and that this section cooperate in organizing and holding a zoological meeting in San Francisco in connection with the Panama Exposition, and it assures these members of the sincere interest and approval of the society in such an undertaking."

A committee on resolutions on the death of Professor Charles Sedgwick Minot and Professor Seth Eugene Meek, consisting of Professors Frank R. Lillie, R. G. Harrison and H. V. Neal, was appointed and instructed to prepare resolutions and publish the same in Science and to transmit copies to the families of the deceased members.

The secretary-treasurer submitted the following financial statement which, having been examined and found correct by the auditing committee, consisting of Professors A. S. Pearse and R. A. Budington, was accepted by the society.

Receipts

1914			
Jan.	1	Balance on hand (Eastern Branch)	$361.71
	18	Received from Treasurer Central Branch	235.51
		Received during the year annual dues from members	247.03
Feb.	14	Received first dividend from the Permanent Fund from the Custodian, J. H. Gerould	22.50
Oct.	13	Received interest on Current Funds on deposit with the Title, Guarantee and Trust Co., Baltimore	23.58
Nov.	11	Received second dividend from the Permanent Fund from Custodian, J. H. Gerould	15.00
		Total receipts	$905.33

Expenditures

Jan.	3	for "Smoker" supplies	$19.00
	14	for circular letter to new members	1.40
	22	for typewriting by-laws for executive committee	1.75
	26	for stamps for mailing the above.	.50
	26	for blanks forms for addresses, etc., of members	1.15
	28	for express on MSS. of Proceedings to Science	.25
	29	for typewriting circular letter to executive committee	.60
	29	for express on "files" from Secretary, Central Branch	1.00
Feb.	6	for 1,000 special stamped (2 c.) envelopes	21.36
	11	for I. P. Binder and two packages *Journal* sheets	2.25
	28	for stamps	1.50
Mch.	31	for addressing and mailing due bills and circular letters	2.55
Apr.	13	for new journal	.50
May	30	for multigraphing blank forms.	1.50
June	6	for typewriting constitution, by-laws, list of members	5.85
	17	for express on files, typewriter and MSS. to Woods Hole	1.60
Sept.	17	for express on MSS. of List of Members to printer	.22
Oct.	1	for express of files and typewriter, Woods Hole to Baltimore	1.60
	24	for 500 copies printed constitution, by-laws, list of members, etc.	75.00
	26	for 500 Columbia Clasp envelopes.	3.50
	26	for 500 copies printed blanks for nominations of new members.	2.75
	26	for mailing copies of Constitution, etc.	7.46
Nov.	4	for 300 copies announcement of Philadelphia meeting	3.25
	4	for mailing announcements to members	1.50
Dec.	4	for 300 copies "Preliminary Program"	18.10
	12	for mailing preliminary programs and map to members.	3.85
	18	for 280 special stamped (1 c.) envelopes	3.09
	26	for 500 printed programs for the annual meeting	10.40
	26	for 500 sheets typewriter paper.	1.90
	28	for R.R. fare of secretary to Philadelphia and return	4.80
	30	for expense incurred by the Secretary in attending the annual meeting	16.00
		Total expenditures	$216.18
		Total receipts	$905.33
Dec.	30	Balance on hand	$689.15

At sessions held during the forenoons and afternoons of December 29 and 30 the following papers were read either in full or by title:

In order to complete the program by the end of the fourth session and thus clear the way for adjournment to attend the session of the Naturalists scheduled for the forenoon of December 31, it was found necessary to provide for the simultaneous meeting of two sections of the Zoologists during the afternoon of December 30. At one of these sectional meetings papers grouped under *General Physiology* and some under *Miscellaneous* were read, and those under *Ecology* and the remaining *Miscellaneous* papers were read at the other. For the same reason practically no time was taken at any session for the discussion of facts and conclusions presented.

Comparative Anatomy

Nerve and Plasmodesma: H. V. NEAL. (With lantern.)

The present paper, based upon observations upon *Squalus* embryos preserved by the Bielchowsky-Paton method, attempts to give an answer to three controverted problems in nerve histogenesis:

1. Are connections between tube and myotome primary or secondary?

2. Are neuromuscular connections primarily undifferentiated plasmodesmata or are they primarily neurofibrillar?

3. Are neuromuscular connections effected by indifferent—neurilemma—cells or by medullary neuroblasts?

The answers given to these questions are:

1. Previous to the stage of 4.5 mm. there are no protoplasmic connections between tube and myotome in *Squalus* embryos.

2. Neurofibrillar substance is present in the first protoplasmic connections between tube and myotome. In the primary protoplasmic connections appear deeply staining neurofibrils which may be traced to bipolar neuroblasts within the neural tube. The claim that the primary connections consist of undifferentiated plasmodesmata therefore is based upon inadequate neurological methods.

3. In stages before protoplasmic connection between tube and myotome is effected certain medullary cells in zones where later the nerve anlagen make their appearance show in Bielchowsky-Paton preparations a deeply-staining neuro-reticulum. In slightly later stages when neuro-muscular connection is established similar neuro-reticular cells are found connected with neurofibrillæ extending into the nerve anlagen in the manner characteristic of medullary neuroblasts stained by specific neuro-fibrillar stains. The evidence of the presence of similar neurofibrillar substance in all parts of the nerve anlagen supports the inference that the neuromuscular connections are established—not by indifferent cells—but by medullary neuroblasts, as maintained by supporters of the Bidder-Kupffer theory. Indifferent cells participate in the formation of nerve anlagen only in more advanced stages by a process of migration from the neural tube.

The Components of the Fenestral Plate in Necturus: H. D. Reed.

In previous communications it has been pointed out that in certain urodele families the sound-transmitting apparatus consists of a single piece resulting from gradual growth during larval and early adult life. In such forms the plate is compound. The stylus represents columella or the extraotic element, while the plate itself arises from chondrification within the fenestral membrane and therefore otic in nature.

The fenestral plate in *Necturus* has been considered as *columella.* It arises outside the ear capsule and gradually comes to lie against the fenestral membrane over the cephalic portion of which it spreads through growth eventually filling the fenestra at this level. Caudad the plate tapers coming to a point at about the middle of the fenestra. The plate thus formed is soon encased in bone. About the margin of this triangular columellar plate cartilage is formed by chondroblasts which arise in the fenestral membrane. The matrix which is soon secreted is invaded by bone deposited in continuity with the previously formed bony case. Thus cell by cell the definitive structure is completed by additions to the margin of the columellar plate. The fenestral plate is to be considered, therefore, as a compound structure possessing both otic and extraotic elements and must be looked upon as a morphologic intermediate of the condition found in *Ambystoma* and the Plethodontidæ.

Variations in the Rays of Ten Thousand Star-Fish, Asterias Forbesii: Franklin D. Barker. (With lantern.)

A New Dignetic Trematode from the Crayfish: John W. Scott.

In 1827 Von Baer described a fluke from the crayfish to which he gave the name *Distomum cirrigerum.* Warren ('03) described its anatomy and development, and Sulowiow ('11) discussed its structure and systematic position. During the past two years trematodes from American crayfish have been secured; these are all encysted, sexually mature, individuals. In certain points they are quite similar to the European form, but the differences are so striking as to place them in different species. Wright ('84) appears to have been the first to observe the fluke in this country, but mistook it for *D. nodulosum.* Linton ('92) gives a brief description of immature specimens, and calls attention to Wright's mistake. The American species differs from the European in the following particulars. It has no conical or plate-like cuticular scales; it has two lateral palp-like extensions of the oral sucker, and four papillæ; the esophagus is short, the gastric coeca arising in front of the genital pit; the yolk glands extend nearer the anterior end of the body; both testes are median, or nearly so, and one lies in front of the other; small cuticular denticles are found on the oral sucker; the cerebral ganglia are wider apart, the prostate gland better developed, and the excretory bladder of somewhat different shape.

A full description of the new form, with a discussion of its probable systematic relationship, will soon be published.

The Reflex "Bleeding" of the Coccinellid Beetle, Epilachna Borealis: N. E. McIndoo.

The Gland of the Clasper in Sharks: E. W. Gudger.

In the claspers of sharks, on the inner and dorsal surface the tissues are modified to form a

groove. This is continued forward between the skin and the pelvic arch where it enlarges to form a sac, which in its turn is extended forward as a tube between the skin and the belly wall. Each tube ends blindly near the median line, in some extending nearly to the pectoral girdle. The function of this organ is entirely unknown.

These structures were described from *Hypoprion brevirostris* and *signatus*, and from the tiger shark, *Galeocerdo tigrinus* captured at Key West and at Tortugas, Florida. The longest gland (one foot, 7¾ inches) was found in a 4 foot, 10 inch specimen of *H. signatus*.

The scanty literature of this organ from its discovery by Andrew Smith in 1849 was briefly sketched. The full data will be given later in an article in "Papers from the Tortugas Laboratory," published by the Carnegie Institution of Washington.

Pre-Otic Somites in Cyclostomes: H. V. Neal. (With lantern.)

Concerning no other criterion of the metamerism of the vertebrate head do observations so fully agree as with regard to the mesodermic divisions discovered by Van Wijhe ('82) in Selachian embryos. His discovery has been confirmed by Miss Platt ('91), Hoffman ('94), Neal ('96), Sewertzoff ('98), Braus ('99) and Johnston ('09). Moreover, Sewertzoff showed that the more numerous "microcœlic" divisions described by Dohrn ('90) and Killian ('91) in *Torpedo* embryos secondarily unite to form the somites of Van Wijhe. Furthermore, a mesodermic segmentation which may be compared with that of Elasmobranchs has been discovered by Miss Platt ('97) in Amphibia and by Koltzoff ('02) in Cyclostomes.

The mesodermic segmentation discovered by Koltzoff ('01) in *Petromyzon* embryos is especially significant and important, since in this animal according to Koltzoff the segmentation of the head mesoderm is complete as in *Amphioxus* and the somites develop as dorso-lateral diverticula of the endoderm. Thus *Petromyzon* is in this respect as in others intermediate between *Acrania* and *Gnathostomata*. Koltzoff finds that the three anteriormost somites give rise to the eye muscles as they do in the Elasmobranchs.

The importance of the evidence as bearing on the past history of the vertebrate head has led me to examine sections of *Petromyzon* embryos in the hope of confirming Koltzoff's results. In at least two series of eight-day *Petromyzon planeri* embryos the evidence presented seems to bear out Koltzoff's contention that the pre-otic segmentation of the mesoderm is comparable with that of Elasmobranch embryos. The anterior head mesoderm is completely segmented as Koltzoff has asserted. No homologue of Miss Platt's "anterior" somites, however, is present in the Cyclostome.

The Absence of Male Reproductive Organs in Trematodes: Franklin D. Barker. (Lantern slides and demonstrations.)

Does Amphioxus Eat with His Left Ear?: H. V. Neal. (With lantern.)

It was Van Wijhe ('93) who first suggested the homology of the larval mouth of *Amphioxus* with the left spiracle of Selachians and asserted that "Amphioxus can not hear; he eats with his left ear and consequently has lost his mouth." The homologue of the craniote mouth in *Amphioxus* is, according to Van Wijhe, the pre-oral pit.

The present paper raises the problem: Are we to accept the homology of the mouth of *Amphioxus* with the spiracular cleft of *Craniotes?*

The homology suggested by Van Wijhe is based on the following grounds:

1. The mouth of *Amphioxus* is an organ of the left side as evidenced by its development, its left-sided innervation and its topographic relations to the club-shaped gland, which Van Wijhe regards as the antimeric gill-pouch.

2. The relations of the larval mouth of *Amphioxus* to the second mesodermic cavity and to the splanchnic muscles derived from it are similar to those of the left spiracle of *Craniotes* to the second mesodermic head-cavity.

Van Wijhe's homology may not be accepted on the following grounds:

1. Since all median openings of *Amphioxus* are asymmetrically displaced, the left-sided position of the mouth is not significant.

2. The left-sided innervation is likewise indecisive. If the homology suggested by Van Wijhe were the correct one, the velum should be innervated by the left nerve of the third pair. It is actually innervated by the left nerves of the 4–7 pairs. Primary nerve relations are obviously disturbed and inferences from innervation precarious.

3. The club-shaped gland and its duct represents a pair of gill-pouches and not a gill-pouch of the right side only, as Van Wijhe's homology would require. The club-shaped gland represents the second pair of gill-pouches and the endostyle anlage the first pair of gill-pouches of *Amphioxus*.

4. The chief objection to the homology maintained by Van Wijhe is the fact that the anterior endodermic diverticula of *Amphioxus* are homologous—not with the pre-mandibular head cavities of Elasmobranchs as assumed by Van Wijhe—but with the "anterior" head cavities. The homologues of the pre-mandibular cavities of Elasmobranchs (the first permanent myotomes) are the first permanent myotomes of *Amphioxus*.

Amphioxus does not eat with his left ear. The homologue of the left spiracle is the first transient gill cleft of *Amphioxus*. The mouth of *Amphioxus*, however, is not homologous with the mouth of *Craniotes*. If it is homologous with any organ of the *Craniotes*, that organ is the hypophysis.

Embryology

Internal Factors Producing the Swarming of the Atlantic Palolo: Aaron L. Treadwell.

Previous explanations of the swarming of annelids have been based on the influence of the external factors such as light, tidal pressure, etc. At the Carnegie Laboratory in the Dry Tortugas I was able with the cooperation of Dr. Tashiro to test the hypothesis that an internal factor cooperates in producing this effect. Since all the eggs of the Atlantic palolo are laid at one definite time, it is possible to test the eggs at any desired interval before the time when they would normally be laid. Testing with his biometer, Dr. Tashiro found that five days before laying each egg gave off 0.000,000,07 grams of CO_2 per minute; two days before laying 0.000,000,083 grams, while eggs taken from the body of a swarming female were eliminating 0.000,000,13 grams per minute. All eggs were taken from the body without mixture with sea water. This indicates an increase in metabolic activity as the time of swarming approaches, and the conclusion follows that this furnishes an internal stimulus of importance in producing the swarm. Probably a similar stimulus is operative in ordinary egg laying.

Are the Taste-buds of Elasmobranchs Endodermal in Origin?: Margaret H. Cook. (Introduced by H. V. Neal.)

An attempt to determine the origin, whether ectodermal or endodermal, of taste-buds in *Squalus acanthias*. A study was made of sections of embryos of 7 to 80 mm. supplemented by dissections of "pup" and adult stages.

Taste-buds in this species are limited to the region of the pharynx, which in all stages of ontogenesis is lined with endoderm. No marked encroachment of the ectoderm is perceptible even in the mouth region.

Scales similar to those which characterize the outer skin arise in late stages of ontogenesis in both the floor and roof of the pharynx. Thus two kinds of organs usually classed as ectodermal, viz., taste-buds and placoid scales, appear to arise from the endoderm of the pharynx of *Squalus acanthias*. To assert that the pharyngeal taste-buds and scales of *Squalus* are ectodermal would necessitate the assumption that the endodermic lining of the pharynx completely disappears during ontogeny and is replaced by ectoderm. Evidence of such substitution is wholly lacking.

These results extend to the Elasmobranchs the conclusion of Johnston ('98 and '10) that the taste-buds of Teleosts and Amphibia are derived from endoderm. They also add to the structures derived from the endoderm the pharyngeal scales which have hitherto been assumed to be ectodermal, and thus add another exception to the law of the specificity of the germ-layers.

On the Larval and Post-larval Development of the Coral, Agaricia Fragilis, Dana: J. W. Mavor. (With lantern.) (Introduced by E. L. Mark.)

Tissue and Organ; Their Rôles in Morphogenesis: Herbert W. Rand.

Definiteness of form is the essential characteristic of an organ. Tissue is without form. Our attempt to discover the factors immediately responsible for the form of an organism will be furthered if we clearly distinguish the parts played by organic units of the several grades. How far does a given formative event depend upon cells acting as uncoordinated individuals, how far does it depend upon a system of cells coordinated into a tissue, and how far does it exhibit the impress of organization higher than that of tissue?

In the wound-closing activities of tentacles of actinians, cells, as such, play a minor and probably unessential part. The definitive structural closure is an autonomous tissue process. Accompanying activities of the neuro-muscular complex afford temporary protection and favor the carrying out of the tissue process. In these activities and in other reactions of the neuro-muscular complex, we observe polarity and a variety of definite relations to the form of the organism. These bespeak for the neuro-muscular complex a degree of organization higher than that of mere tissue, probably corresponding to the organism as a whole.

The neuro-muscular complex may be regarded as standing at a threshold of organization. Morphologically standing at the level of a tissue, it exhibits the physiological definiteness and differentiation which characterize an organ. Thus, in a sense, function anticipates structure.

(Based upon a paper now in press in *Archiv für Entwickelungsmechanik der Organismen.*)

The Form of the Stomach in Embryos of the Cat, Albino Rat, Pig and Sheep: CHESTER H. HEUSER.

Utero-gestation in the Sheep-nosed Shark, Scoliodon Terranovæ: E. W. GUDGER.

In a 37½-inch specimen with a girth of 13½ inches taken at Tortugas, Florida, the left ovary was twice as long as the non-functional left lobe, while the oviducal apparatus was paired, symmetrical, and had both sides functional. The eggs, each enclosed in a thin yellow shell with its long pointed ends curiously folded and plaited, lay in crypt-like lateral "nests" formed in the mucous lining of the uteri. The structure of the uterus and the formation of the "nests," with the relation thereto of the curious shells, were described and illustrated, as were also the young and their connection with the yolk and finally with the uterine wall. In all respects the eggs and their shells together with the uteri containing them are in close parallel with similar structures in the bonnet-head shark, *Sphyrna tiburo,* reported on by the speaker at the Princeton meeting of the society in 1911.

An article giving all the data at hand and illustrated by photographs will appear later in "Papers from the Tortugas Laboratory" of the Carnegie Institution of Washington.

Experimentally Fused Larvæ, with Special Reference to Changes in Polarity, Symmetry, Synchronity, Etc.: A. J. GOLDFARB.

Experiments in Cleavage: T. S. PAINTER. (Introduced by R. G. Harrison.)

Cytology

A Study of the Maturation Period in the American and European Molecrickets: F. PAYNE.

Regenerative Potencies of Dissociated Cells of Hydromedusæ: CHARLES W. HARGITT.

The paper describes experiments made at the Zoological Station, Naples, several years ago. About a dozen species of hydroids, and one species of medusa were experimented on, and with results which in the main confirm those of H. V. Wilson, published since my own were made. The paper also briefly reviews a series of similar experiments made by DeMorgan and Drew.[1] These latter experiments are the immediate occasion for giving publicity to my own work, as they appear to imply some doubt as to the conclusiveness of Wilson's work. Their experiments were made upon two species of *Antennularia,* and while serving to confirm earlier phases of those of Wilson they never gave rise to new hydranths. The authors declare "our experiments have resulted in the production of masses that are certainly abnormal and pathological, but nevertheless we would submit that the segregation and rearrangement of the cells after isolation, and the considerably long duration of life of the tumor-like masses to which they give rise, are facts of considerable theoretical interest."

The paper will show that the assumption as to the abnormality and pathological conditions apparent are not warranted by the more extended knowledge of facts from these and other sources. Indeed, many facts concerning the behavior of these organisms in development and regeneration seem to prove that fundamentally there is neither abnormality nor pathological process involved.

Microdissection Studies on the Physical Properties and Behavior of Cell Structures, Especially in Orthopteran Spermatogenesis: ROBERT CHAMBERS, JR.

Cells studied were of Orthopteran gonads, plant-root tips and pancreas of frog. Fresh material corroborates in many interesting details nuclear structures observed in fixed material. Mitochondria and the cytoplasm, however, largely show artifacts with fixatives.

Puncture of a cell by a needle generally causes irreparable injury. Slight injury hastens the normal reversible changes in the physical states of the colloids in the cell, but soon transforms them to an abnormal condition which leads to death.

Injury to the cell is followed by swelling accompanied by an increased imbibition of water.

Physiological salt solutions are more or less injurious to cells normally bathed in organic fluids.

A tension exists in the cell during division which is lost when any part of the cell is torn.

Janus green (Hoechst) stains mitochondria rapidly. In the nucleus it is reduced to safranin, which kills the cell.

[1] *Jour. Marine Biol. Assoc.,* Plymouth, October, 1914.

Janus green produces coagulation phenomena in living protoplasm and therefore should not be used to identify mitochondria.

The mitochondria are rigid structures. In the Orthopteran germ they all change from granules to strands, they coalesce, they disappear and reappear and may be expressions of changes in the physical states of the cytoplasmic colloids.

The chromosomes behave almost as do the mitochondria. In the hyaline resting nucleus they appear in the form of granules ranged about a hyaline resistant core. The granules coalesce to form the homogeneous body of the metaphase chromosomes. In telophase the chromosomes swell and disappear. Some internal chemical condition may exist which so regulates the physical states of the nuclear colloids that a constant number of chromosomes periodically appears.

Spermatogenesis in Paratettix: MARY T. HARMAN.

1. The chromosomal complex of the spermatogonial divisions of *Paratettix leuconotus—leucothorax* consists of thirteen rod-shaped chromosomes which may be divided into two groups, one consisting of four large chromosomes and the other of nine smaller ones.

2. Eight of the smaller chromosomes are straight rods; one of the smaller ones and all of the larger ones are U-shaped. The chromosomes do not form equal pairs.

3. In the metaphase stage the chromosomes are at right angles to the spindle fibers, but in the anaphase they are parallel to them.

4. One chromosome is always far to the center of the spindle. Sometimes it is completely surrounded by the others and sometimes merely one end is at the center of the spindle. It is never the bent chromosome but is always one of the larger ones of the group of nine.

5. In the early prophases is always a mass of chromatin which never takes on the reticular condition, but has a more compact consistency and stains more intensely than the remainder of the chromatin material.

6. At the beginning of the growth period the nucleus becomes large, and some of the chromatin takes on the reticular condition and stains lightly, but there is one mass that is compact, stains intensely and has the appearance of a nucleolus. It forms the accessory chromosome.

7. In synizesis there is no polarization of the chromatin thread.

8. In the primary spermatocyte are always six dumb-bell-shaped chromosomes but two are much larger than the others.

9. The first spermatocyte division is always a cross division. The accessory chromosome always lies near the periphery of the spindle and passes to one pole undivided much in advance of the others.

10. All the chromosomes divide in the second spermatocyte division.

Synapsis and the Individuality of the Chromosomes: D. H. WENRICH.

In attempting to determine whether synapsis in this Acridid grasshopper is end-to-end (telosynapsis) or side-by-side (parasynapsis), it was found that the only method by which conclusive evidence could be obtained was that of following the history of individual chromosomes.

Of the 12 haploid chromosomes present in this species, at least three were found to possess individual peculiarities by which they could be recognized throughout the growth period and the prophases of the first maturation division.

Parallel conjugation of the fine spireme threads of the early growth stages appeared to occur as a general rule, and different steps in the process could be followed for at least one of the differential chromosomes. Conjugation did not result in loss of identity of the uniting threads in the sense of forming "mixochromosomes," for the plane of separation between them remained visible throughout the spireme stages. However, pairs of granules often appeared to be fused into single ones. Spireme segments separate out as rods or loops with a single split, tetrads being formed by a second longitudinal split at right angles to the one already present.

Analysis of the spireme stages of one of the differential chromosomes revealed a seriation of granules (chromosomes) along its length, such that the relative size and position of the granules were constant not only in the cells of one individual, but in those of all the animals studied.

Chromosomes with peculiarities analogous to those found in the first spermatocyte could be recognized in the spermatogonia.

In the first maturation division the monosome passes to one pole undivided. The tetrads appear to divide equationally with one exception. In this tetrad the conjugants are very unequal and division is as often reductional as equational. When dividing reductionally the unequal dyads show, with reference to the monosome, a distribution according to the law of chance (Mendel's law).

The Orientation of the Nuclear Contents in the Motor Electric Cells of Torpedos: ULRIC DAHLGREN. (With lantern.)

The nucleus contains, besides the usual chromatin bodies, a large typical plasmosome and a somewhat smaller body, the para-nucleolus. These two are always oriented in a dorso-ventral position and the cause of this orientation was sought in either the electric current that passes through the tissue or in the influence of gravity. Electric currents of the same strength as those generated by the fish and when applied at right angles to or directly against the orientation in question failed to influence it even when applied for several hours. Stronger currents moved the nuclear contents, but also changed the structure and chemical composition of the parts. One fact seemed to be shown; that the plasmosome was not moved to either pole of the nucleus, but assumed a position between two materials that did occupy the two halves of the nucleus.

Gravity experiments were interesting and seemed to solve the question; at a lower rate of centrifugal force the plasmosome was moved to the side of the nucleus away from the force. At a higher rate the chromatin bodies were also moved, while with the greatest force used the paranucleus was also moved. The Naples torpedos possess no paranucleolus in these cells.

Genetics

Bristle Inheritance in Drosophila: E. CARLETON MACDOWELL. (With lantern.)

A race of *Drosophila ampelophila* has been established from wild flies that has extra thoracic bristles. Crosses with normal flies prove that the extra bristled condition is a recessive Mendelian character. The number of extra bristles that appear in this race varies. The first six generations from parents selected for increase in bristle number showed a steady rise in the numbers of bristles. For thirteen generations after this, selection was apparently ineffective.

Three interpretations of successful selection may be examined.

1. Determiners may be inconstant; higher grades of a character have higher grade determiners. This would not account for the thirteen generations of ineffective selection, nor the genetic uniformity in the later generations which is evidenced by, (*a*) high and low grade parents from the same family giving like offspring, (*b*) analysis of high and low grades by crosses, (*c*) absence of correlation between means of parents and offspring in whole generations after the sixth.

2. Selection may produce a more vigorous line, and this vigor may occasion the better development of the character. A large fly in the *extra* race is apt to have more bristles than a small one.

3. Multiple factors may exist which are reduced to a homozygous condition by selection. Extracted extra bristles have a lower distribution than the uncrossed *extras*, yet the high extremes of the selected race are equalled. This would be the result if selection had removed some accessory restricting genes. These facts do not agree with the second interpretation, whereas all observations are in accord with the third interpretation.

The Behavior of a Unit Character in the Grouse Locust, Paratettix: ROBERT K. NABOURS.

Size Dimorphism in the Spermatozoa and Its Relation to the Chromosomes: CHARLES ZELENY AND E. C. FAUST.

Further evidence has been obtained in favor of the view that the size dimorphism of the spermatozoa observed in several species by the authors is correlated with the chromosomal dimorphism of the spermatids. The ratio between the chromosomal volumes was calculated from published figures of the spermatogenesis in the three species, *Musca domestica, Alydus pilosulus* and *Anasa tristis*. From this ratio the expected ratio between the head lengths in the resulting spermatozoa was calculated on the assumption that the size of the heads is directly proportional to the amount of chromatin received and on the further assumption that the shape of the heads is the same for all sizes. The calculated ratios and the corresponding observed ratios are as follows: *Alydus pilosulus*, calculated 1.00:1.06, observed 1.00:1.055; *Musca domestica*, calculated 1.00:1.08, observed 1.00:1.07; *Anasa tristis*, calculated 1.00:1.11, observed 1.00: 1.09. Complete data were given in the February, 1915, number of the *Journal of Experimental Zoology*.

Sex Controlled by Food Conditions in Hydatina Senta: DAVID D. WHITNEY.

The cause of the erratic proportion of the two sexes in *Hydatina senta* has been found to be due to diet. When three pedigreed parthenogenetic races of these rotifers were reared in the laboratory on a constant and uniform diet of a colorless flagellate, *Polytoma*, through 181–288 generations in 14–22 months they produced 96 per cent. to 100

per cent. of female grandchildren, thus showing that uniform food conditions cause nearly all females to be produced. However, when these rotifers that were producing almost exclusively female grandchildren on a uniform diet were suddenly put upon a new diet of the green flagellate, *Chlamydomonas*, they almost ceased producing female grandchildren and produced as high as 83 per cent. of male grandchildren. Moreover, if the first few eggs of each female that were laid in the *Chlamydomonas* diet were discarded all the grandchildren were males, thus showing that a sudden change from a uniform diet to a new diet causes the total suppression of nearly all females and the production of nearly all males.

Parthenogenesis and Sex in Anthothrips Verbasci: A. FRANKLIN SHULL.

The life cycle of few species of *Thysanoptera* is definitely and completely known. In general, sexual reproduction has been inferred in species having abundant males, especially if mating has been observed in nature. Such a species is *Anthothrips verbasci*, the mullein thrips. However, adult females reared in isolation from pupæ, and placed on thrips-free plants, have given rise to offspring. These offspring must have been produced parthenogenetically. It is not safe, therefore, to infer merely from the abundance of males or the occurrence of copulation, that *any* species is sexual. Whether *Anthothrips verbasci* exhibits both parthenogenetic and sexual reproduction has not yet been determined.

Twenty-eight of the parthenogenetically produced young have reached stages sufficiently advanced to allow their sex to be recognized. All were males. This suggests that the same relation exists between parthenogenesis and sex as in the honey bee and some other Hymenoptera, though other explanations are obviously possible.

Sex Control and Known Correlations in Pigeons: OSCAR RIDDLE.

Some Internal Factors Influencing Egg Production in the Rhode Island Red Breeds of Domestic Fowl: H. D. GOODALE.

Multiple Human Births: G. H. PARKER.

A Note on the Origin of a Color Variety of Mice: CLARENCE C. LITTLE.

A Modification of the Agouti Factor in a Cavy Species Cross: J. A. DETLEFSEN. (Introduced by W. E. Castle.)

The agouti character of the wild Brazilian cavy, *Cavia rufescens*, acts as a single unit in heredity, when transmitted to hybrids between this species and the tame species, *C. porcellus*. This unit character, however, is often modified in the hybrids. The modification is essentially a weakening in the power to restrict black and brown pigments from the sub-apical portion of the hair. The weakened modified agouti character of the hybrids was found to be a recessive in crosses with the normal agouti guinea-pig. The normal agouti of the tame guinea-pig, the modified agouti of the hybrids, and non-agouti, are triple-allelomorphs.

The Effects of Long-continued Parthenogenetic Reproduction (127 Generations) upon Daphnids: A. M. BANTA.

The writer has kept pure lines of *Daphnia pulex* reproducing continuously by parthenogenesis alone for over three years. Some of the lines have now reached the 127th generation. If the sexual cycle is a necessary and essential feature of reproduction in this species the fact should ultimately become evident in the reduced vigor in the parthenogenetic lines. In order to discover if any reduction in vigor had actually occurred some "wild" *Daphnia pulex* were obtained from out-door ponds. These "wild" lines were treated in every way identically (except that no selection was made with them as with the older lines) with the lines already under observation. The age of the mother at the time her first brood appeared, the number of individuals in the first brood and the interval until a second brood was produced were taken as measures of the vigor of the individual. Average values obtained from large numbers of mothers of the "wild" lines and of the selection lines constituted the data finally obtained.

Measured by these standards, the lines reproducing parthenogenetically from the 70th to the 92d generation under laboratory conditions possessed somewhat less vigor than wild lines descending from the 1st to the 23d generation under laboratory conditions. During the summer (1914) food conditions were quite unfavorable. "Wild" lines descending from the 2d to the 9th generation showed a *marked* superiority in vigor as compared with the lines which during the same descended from the 96th to the 103d generation. However on the return of normally favorable food conditions the lines long reproducing parthenogenetically under laboratory conditions actually on each of the three points of comparison appeared to have a superiority of vigor.

CASWELL GRAVE,
Secretary-Treasurer

(To be continued)

SCIENCE

FRIDAY, MARCH 26, 1915

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

GRADUATE MATHEMATICAL INSTRUCTION FOR GRADUATE STUDENTS NOT INTENDING TO BECOME MATHEMATICIANS[1]

IN his "Annual Report" under date of November last, the President of Columbia University speaks in vigorous terms of what he believes to be the increasing failure of present-day advanced instruction to fulfil one of the chief purposes for which institutions of higher learning are established and maintained.

President Butler, in the course of an interesting section devoted to college and university teaching, says:

> A matter that is closely related to poor teaching is found in the growing tendency of colleges and universities to vocationalize all their instruction. A given department will plan all its courses of instruction solely from the point of view of the student who is going to specialize in that field. It is increasingly difficult for those who have the very proper desire to gain some real knowledge of a given topic without intending to become specialists in it. A university department is not well organized and is not doing its duty until it establishes and maintains at least one strong substantial university course designed primarily for students of maturity and power, which course will be an end in itself and will present to those who take it a general view of the subject-matter of a designated field of knowledge, its methods, its literature and its results. It should be possible for an advanced student specializing in some other field to gain a general knowledge of physical problems and processes without becoming a physicist; or a general knowledge of chemical problems and processes without becoming a chemist; or a general knowledge of zoological problems and processes without becoming a zoologist, or a general

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knowledge of mathematical problems and processes without becoming a mathematician.

This is a large matter, involving all the cardinal divisions of knowledge. I have neither time nor competence to deal with it fully or explicitly in all its bearings. As indicated by the title of this address it is my intention to confine myself, not indeed exclusively but in the main, to consideration of the question in its relation to advanced instruction in mathematics. The obvious advantages of this restriction will not, I believe, be counterbalanced by equal disadvantages. For, much as the principal subjects of university instruction differ among themselves, it is yet true that as instruments of education they have a common character and for their efficacy as such depend fundamentally upon the same educational principles. A discussion, therefore, of an important and representative part of the general question will naturally derive no little of whatever interest and value it may have from its implicit bearing upon the whole. It is not indeed my intention to depend solely upon such implicit bearings nor upon the representative character of mathematics to intimate my opinion respecting the question in its relation to other subjects. On the contrary, I am going to assume that specialists in other fields will allow me, as a lay neighbor fairly inclined to minding his own affairs, the privilege of some quite explicit preliminary remarks upon the larger question.

I suspect that my interest in the matter is in a measure temperamental; and my conviction in the premises, though it is not, I believe, an unreasoned one, may be somewhat colored by inborn predilection. At all events I own that a good many years of devotion to one field of knowledge has not destroyed in me a certain fondness for avocational studies, for books that deal with large subjects in large ways, and for men who, uniting the generalist with the specialist in a single gigantic personality, can show you perspectives, contours and reliefs, a great subject or a great doctrine in its principal aspects, in its continental bearings, without first compelling you to survey it pebble by pebble and inch by inch. I can not remember the time when it did not seem to me to be the very first obligation of universities to cherish instruction of the kind that is given and received in the avocational as distinguished from the vocational spirit—the kind of instruction that has for its aim, not action but understanding, not utilities but ideas, not efficiency but enlightenment, not prosperity but magnanimity. For without intelligence and magnanimity—without light and soul—no form of being can be noble and every species of conduct is but a kind of blundering in the night. I could hardly say more explicitly that I agree heartily and entirely with the main contention of President Butler's pronouncement. Indeed I should go a step further than he has gone. He has said that a university *department* is not well organized and is not doing its duty until it establishes and maintains the kind of instruction I have tried to characterize. To that statement I venture to add explicitly—what is of course implicit in it—that a *university* is not well organized and is not doing *its* duty until it makes provision whereby the various departments are enabled to foster the kind of instruction we are talking about. That in all major subjects of university instruction there ought to be given courses designed for students of "maturity and power" who, whilst specializing in one subject or one field, desire to generalize in others, appears to me to be from every point of view so reasonable and just a proposition that it would not occur to me to regard it as questionable or debatable were it not for the fact that it actually is questioned and debated by teachers of eminence and authority.

What is there in the contention about which men may differ? Dr. Butler has said that there is a "growing tendency of college and university departments to vocationalize all their instruction." Is the statement erroneous? It may, I think, be questioned whether the tendency is growing. I hope it is not. Of course specialization is not a new thing in the world. It is far older than history. Let it be granted that it is here to stay, for it is indispensable to the advancement of knowledge and to the conduct of human affairs. Every one knows that. There is, however, some evidence that specialization is becoming, indeed that it has become, wiser, less exclusive, more temperate. The symptoms of what not long ago promised to become a kind of specialism mania appear to be somewhat less pronounced. Recognition of the fact that specialization is in constant peril of becoming so minute and narrow as to defeat its own ends is now a commonplace among specialists themselves, many of whom have learned the lesson through sad experience, others from observation. Specialists are discoverers. One of our recent discoveries is the discovery of a very old truth: we have discovered that no work can be really great which does not contain some element or touch of the universal, and that is not exactly a new insight. Leonardo da Vinci says:

> We may frankly admit that certain people deceive themselves who apply the title "a good master" to a painter who can only do the head or the figure well. Surely it is no great achievement if by studying one thing only during his whole lifetime he attain to some degree of excellence therein!

The conviction seems to be gaining ground that in the republic of learning the ideal citizen is neither the ignorant specialist, however profound he may be, nor the shallow generalist, however wide the range of his interest and enlightenment. It is not important, however, in this connection to ascertain whether the vocationalizing tendency is at present increasing or decreasing or stationary. What is important is to recognize the fact that the tendency, be it waxing or waning, actually exists, and that it operates in such strength as practically to exclude all provision for the student who, if I may so express it, would qualify himself to gaze into the heavens intelligently without having to pursue courses designed for none but such as would emulate a Newton or a Laplace. If any one doubts that such is the actual state of the case, the remedy is very simple: let him choose at random a dozen or a score of the principal universities and examine their bulletins of instruction in the major fields of knowledge.

Another element—an extremely important element—of President Butler's contention is present in the form of a double assumption: it is assumed that in any university community there are serious and capable students whose primary aim is indeed the winning of mastery in a chosen field of knowledge but who at the same time desire to gain some understanding of other fields—some intelligence of their enterprises, their genius, their methods and their achievements; it is further assumed that this non-vocational or avocational propensity is legitimate and laudable. Are the assumptions correct? The latter one involves a question of values and will be dealt with presently. In respect of the former we have to do with what mathematicians call an existence theorem: Do the students described exist? They do. Can the fact be demonstrated—deductively proved? It can not. How, then, may we know it to be true? The answer is: partly by observation, partly by experience, partly by inference and partly by being candid with ourselves. Who is there among us that is unwilling to admit that he himself now is or at least once was a student of the kind?

Where is the university professor to whom such students have not revealed themselves as such in conversation? Who is it that has not learned of their existence through the testimony of others? No doubt some of us not only have known students of the kind, but have tried in a measure to serve them. We may as well be frank. I have myself for some years offered in my subject a course designed in large part for students having no vocational interest in mathematics. I may be permitted to say, for what the testimony may be worth, that the response has been good. The attendance has been composed about equally of students who were not looking forward to a career in mathematics and of students who were. And this leads me to say, in passing, that, if the latter students were asked to explain what value such instruction could have for them, they would probably answer that it served to give them some knowledge *about* a great subject which they could hardly hope to acquire from courses designed solely to give knowledge *of* the subject. Every one knows that it often is of great advantage to treat a subject as an object. One of the chief values of n-dimensional geometry is that it enables us to contemplate ordinary space from the outside, as even those who have but little imagination can contemplate a plane because it does not immerse them. Returning from this digression, permit me to ask: if, without trying to discover the type of student in question, we yet become aware, quite casually, that the type actually exists, is it not legitimate to infer that it is much more numerously represented than is commonly supposed? And if such students occasionally make their presence known even when we do not offer them the kind of instruction to render their wants articulate, is it not reasonable to infer that the provision of such instruction would have the effect of revealing them in much greater numbers?

Indeed it does not seem unreasonable to suppose that a "strong substantial course" of the kind in question, in whatever great subject it were given, would be attended not only by considerable numbers of regular students but in a measure also by officers of instruction in other subjects and even perhaps by other qualified residents of an academic community. Only the other day one of my mathematical colleagues said to me that he would rejoice in an opportunity to attend such a course in physics. The dean of a great school of law not long ago expressed the wish that some one might write a book on mathematics in such a way as would enable students like himself to learn something of the innerness of this science, something of its spirit, its range, its ways, achievements and aspiration. I have known an eminent professor of economics to join a beginners' class in analytical geometry. Very recently one of the major prophets of philosophy declared it to be his intention to suspend for a season his own special activity in order to devote himself to acquiring some knowledge of modern mathematics. Similar instances abound and might be cited by any one not only at great length, but in connection with every cardinal division of knowledge. Their significance is plain. They are but additional tokens of the fact that the race of catholic-minded men has not been extinguished by the reigning specialism of the time, but that among students and scholars there are still to be found those whose curiosity and intellectual interests surpass all professional limits and crave instruction more generic in kind, more liberal, if you please, and ampler in its scope, than our vocationalized programs afford.

As to the question of values, I maintain

that the desire of such men is entirely legitimate, that it is wholesome and praiseworthy, that it deserves to be stimulated, and that universities ought to meet it, if they can. Indeed, all this seems to me so obvious that I find it a little difficult to treat it seriously as a question. If the matter must be debated, let it be debated on worthy ground. To say, as proponents sometimes say, that, inasmuch as all knowledge turns out sooner or later to be useful, students preparing for a given vocation by specializing in a given field may profitably seek some general acquaintance with other fields *because* such general knowledge will indirectly increase their vocational equipment, is to offer a consideration which, though in itself it is just enough, yet degrades the discussion from its appropriate level, which is that of an ideal humanity, down to the level of mere efficiency and practicianism. No doubt one engaged in minutely studying the topography of a given locality because he intends to reside in it might be plausibly advised to study also the general geography of the globe on the ground that his special topographical knowledge would be thus enhanced, and that, moreover, he might some time desire to travel. But if we ventured to counsel him so, he might reply: What you say is true. But why do you ply me with such low considerations? Why do you regard me as something crawling on its belly? Don't you know that I ought to acquire a general knowledge of geography, not primarily because it may be useful to me as a resident here or as a possible traveler, but because such knowledge is essential to me in my character as a man? The rebuke, if we were fortunately capable of feeling it, would be well deserved. A man building a bridge is greater than the engineer; a man planting seed is greater than the farmer; a man teaching calculus is greater than the mathematican; a man presiding at a faculty meeting is greater than the dean or the president. We may as well remember that man is superior to any of his occupations. His supreme vocation is not law or medicine or theology or commerce or war or journalism or chemistry or physics or mathematics or literature or any specific science or art or activity; it is intelligence, and it is this supreme vocation of man as man that gives to universities their supreme obligation. It is unworthy of a university to conceive of man as if he were created to be the servant of utilities, trades, professions and careers; these things are for *him*: not ends but means. It is said that intelligence is good because it prospers us in our trades, industries and professions; it ought to be said that these things are good because and in so far as they prosper intelligence. Even if we do not conceive the office of intelligence to be that of contributing to being in its highest form, which consists in understanding, even if we conceive its function less nobly as that of enabling us to adjust ourselves to our environment, the same conclusion holds. For what is our environment? Is it wholly or mainly a matter of sensible circumstance—sea and land and sky, heat and cold, day and night, seasons, food, raiment, and the like? Far from it. It is rather a matter of spiritual circumstances—ideas, sentiments, doctrines, sciences, institutions, and arts. It is in respect of this ever-changing and ever-developing world of spiritual things, it is in respect of this invisible and intangible environment of life, that universities, whilst aiming to give mastery in this part or that, are at the same time under equal obligation to give to such as can receive it some general orientation in the whole.

And now as to the question of feasibility. Can the thing be done? So far as mathematics is concerned I am confident that

it can, and I have a strong lay suspicion that it can be done in all other subjects.

It is my main purpose to show, with some regard to concreteness and detail, that the thing is feasible in mathematics. Before doing so, however, I desire to view the matter a little further in its general aspect and in particular to deal with some of the considerations that tend to deter many scientific specialists from entering upon the enterprise.

One of the considerations, and one, too, that is often but little understood, and so leads to wrong imputations of motive, though it is in a sense distinctly creditable to those who are influenced by it, is the consideration that relates to intricacy and technicality of subject-matter and doctrine. Every specialist knows that the principal developments in his branch of science are too intricate, too technical and too remote from the threshold of the matter to be accessible to laymen, whatever their abilities and attainments in foreign fields. Not only does he know that there is thus but relatively little of his science which laymen can understand but he knows also that the portions which they can not understand are in general precisely those of greatest interest and beauty. And knowing this, he feels, sometimes very strongly, that were he to endeavor by means of a lecture course to give laymen a general acquaintance with his subject, he could not fail to incur the guilt of giving them, not merely an inadequate impression, but an essentially false impression, of the nature, significance and dignity of a great field of knowledge. His hesitance therefore, is not due, as it is sometimes thought to be, to indifference or to selfishness. Rather is it due to a sense of loyalty to truth, to a sense of veracity, to an unwillingness to mislead or deceive. Of course strange things do sometimes happen, and it is barely conceivable that once in a long time nature may, in a sportive mood, produce a kind of specialist whose subject affects him much as the possession of an apple or a piece of candy affects the boy who goes round the corner in order to have it all himself. But if the type exist, not many men could claim the odd distinction of belonging to it. Specialists are as generous and humane as other men. Their subjects affect them as that same boy is affected when, if he chance to come suddenly upon some strange kind of flower or bird, he at once summons his sister or brother or father or mother or other friend to share in his surprise and joy. There is this difference, however—the specialist must, unfortunately, suffer *his* joy in solitude unless and until he finds a comrade in kind. I admit that the deterrent consideration in question is thoroughly intelligible. I contend that the motive it involves presents an attractive aspect. But I can not think it of sufficient weight to be decisive. It involves, I believe, an erroneous estimate of values, a fallacious view of the ways of truth to men. A few years ago, when making a railway journey through one of the most imposing parts of the Rocky Mountains, I was tempted like many another passenger to procure some photographs of the scenery in order to convey to far-away friends some notion of the wonders of it. So far, however, did the actual scenery surpass the pictures of it, excellent as these were, that I decided not to buy them, feeling it were better to convey no impression at all than to give one so inferior to my own. No doubt the decision might be defended on the ground of its motive. Did it not originate in a certain laudable sense of obligation to truth? Nevertheless, as I am now convinced, the decision was silly. For in accordance with the same principle it is plain that I ought to have wished to have my own impressions

erased, seeing that they must have been quite as inferior to those of a widely experienced mountaineer as those which the pictures could have given were inferior to mine. Who is so foolish as to argue that no one should learn anything about, say London, unless he means to master all its plans, its architecture and its history in their every phase, feature and detail? Who would contend that, because we are permitted to know only so little of what is happening in the European war, we ought to remain in total ignorance of it? Who would say that no one may with propriety seek to learn something about ancient Rome unless he is bent on becoming a Gibbon or a Mommsen? It is undoubtedly true that an endeavor to present a body of doctrine or a science to such as can not receive it fully must result in giving a false impression of the truth. But the notion that such an endeavor is therefore wrong is a notion which, if consistently and thoroughly carried out, would put the human mind entirely out of commission. All impressions, all views, all theories, all doctrines, all sciences are false in the sense of being partial, imperfect, incomplete. "Il n'y a plus des problèmes résolus et d'autres qui ne le sont pas, il y a seulement des problèmes *plus ou moins* résolus," said Henri Poincaré. Every one must see that, but for the helpfulness of views which because incomplete are also in a measure false, even the practical conduct of life, not to say the advancement of science, would be impossible. There is no other choice: either we must subsist upon fragments or perish.

Again, many a specialist shrinks from trying to present his subject to laymen because he looks upon such activity as a species of what is called popularization of science, and he believes that such popularization, even in its best sense, closely resembles vulgarization in its worst. He fancies that there is a sharp line bounding off knowledge that is mere knowledge from knowledge that is scientific. In his view science is for specialists and for specialists only. He declines, on something like moral and esthetic grounds, to engage in what he calls playing to the gallery. It might, of course, be said that there is more than one way of playing to the gallery. It could be said that one way consists in acting the rôle of one who imagines that his intellectual interests are so austere and elevated and his thought so profound that a just sense of the awful dignity of his vocation imposes upon him, when in presence of the vulgar multitude, the solemn law of silence. It would be ungenerous, however, if not unfair, to insist upon the justice of such a possible retort. Rather let it be granted, for it is true, that much so-called popularization of science *is* vicious, relieving the ignorant of their modesty without relieving them of their ignorance, equipping them with the vocabulary of knowledge without its content and so fostering not only a vain and empty conceit, but a certain facility of speech that is seemly, impressive and valuable only when, as is too seldom the case, it is accompanied by solid attainments. To say this, however, is not to lay an indictment against that kind of scientific popularization which was so happily illustrated by the very greatest men of antiquity, which was not disdained even by Galileo in the beginnings of modern science nor by Leonardo da Vinci, and which in our own time has engaged the interest and skill of such men as Clifford and Helmholtz, Haeckel and Huxley, Mach, Ostwald, Enriques and Henri Poincaré. It is not to arraign that variety of popularization which any one may behold in the constant movement of ideas, once reserved exclusively for graduate students, down into undergraduate curricula and which has,

for example, made the doctrine of limits, analytical geometry, projective geometry, and the notions of the derivative and the integral available for presentation to college freshmen or even to high-school pupils. It is not to condemn that kind of popularization which is so natural a process that it actually goes on in a thousand ways all about us without our deliberate cooperation, without our intention or our consent, and has enriched the common sense and common knowledge of our time with countless precious elements from among the scientific and philosophic discoveries made by other generations of men.

Finally it remains to mention the important type of specialist in whom strongly predominates the predilection for research as distinguished from exposition. He knows, as every one knows, that through what is called practical applications of science many a scientific discovery is made to serve innumerable human beings who do not understand it and innumerable others who never can. He may or may not believe in avocational instruction; he may or may not regard intelligence as an ultimate good and an end in itself; he may or may not think that the arts and agencies for the dissemination of knowledge, as distinguished from the discovery and practical applications of truth, are important; he may or may not know that the art and the gifts of the great expositor are as important and as rare as those of the great investigator and less often owe their success to the favor of accident or chance. He may not even have seriously considered these things. He does know his own predilection; and so strong is his inclination towards research that for *him* to engage in exposition, espepecially in popular exposition, in avocational instruction for laymen, would be to sin against the authority of his vocation. This man, if he have intellectual powers fairly corresponding to the seeming authority and urgence of his inner call, belongs to a class whose rights are peculiarly sacred and whose freedom must be guarded in the interest of all mankind. It is not contended that every representative of a given subject is under obligation to expound it for the avocational interest and enlightenment of laymen. The contention is that such exposition is so important a service that any university department should contain at least one man who is at once willing and qualified to render it.

I come now to the keeping of my promise. It is to be shown that the service is practicable in the subject of mathematics and how it is so. Let us get clearly in mind the kind of persons for whom the instruction is to be primarily designed. They are to be students of "maturity and power"; they do not intend to become teachers, much less producers, of mathematics; they are probably specializing in other fields; they do not aim at becoming mathematicians; their interest in mathematics is not vocational, it is avocational; it is the interest of those whose curiosity transcends the limits of any specific profession or any specific form or field of activity; each of them knows that, whatever his own field may be, it is penetrated, overarched, compassed about by an infinitely vaster world of human interests and human achievements; they feel its immense presence, the poignant challenge of it all; as specialists they will win mastery over a little part, but they have heard the call to intelligence and are seeking orientation in the whole; this they know is a thing of mind; they are aware that the essential environment of a scholar's life is a spiritual environment—the invisible and intangible world of ideas, doctrines, institutions, sciences and arts; they know or they suspect that one of the great components of that world is mathematics; and so, not as candidates for a profession or a degree, but in their higher

capacity as men and women, they desire to learn something of this science viewed as a human enterprise, as a body of human achievements; and they are willing to pay the price; they are not seeking entertainment, they are prepared to work—to listen, to read and to think.

And now we must ask: What measure of mathematical training is to be required of them as a preparation? In view of what has just been said it is evident that such training is not to be the whole of their equipment nor even the principal part of it, but it is an indispensable part. And the question is: How much mathematical knowledge and mathematical discipline is to be demanded? I have no desire to minimize my present task. I, therefore, propose that only so much mathematical preparation shall be demanded as can be gained in a year of collegiate study. Most of them will, of course, have had more; but I propose as a hypothesis that the amount named be regarded as an adequate minimum. But it does not include the differential and integral calculus. And is it not preposterous to talk of offering graduate instruction in mathematics to students who have not had a first course in the calculus? I am far from thinking so. A little reflection will suffice to show that in the case of such students as I have described it is very far from preposterous. In my opinion the absurdity would rather lie in demanding the calculus of them. No one is so foolish as to contend that a first course in the calculus is a *sufficient* preparation for undertaking the pursuit of graduate mathematical study. But to suppose it necessary is just as foolish as to suppose it sufficient. There was a time when it *was* necessary, and the belief that it is necessary now owes its persistence and currency to the inertia then acquired. Formerly it was necessary, because formerly all advanced courses, at least all initial courses of the kind, were either prolongations of the calculus, like differential equations, for example, or else courses in which the calculus played an essential instrumental rôle as in rational mechanics, or the usual introductions to function theory or to higher geometry or algebra. But, as every mathematician knows, that time has passed. It is true that courses for which a preliminary training in the calculus is essential still constitute and will continue to constitute the major part of the graduate offer of any department of mathematics. And quite apart from that consideration, it seems wise, in the case of intending graduate students who purpose to specialize in mathematics, to enforce the usual calculus requirement as affording some slight protection against immaturity and the lack of seriousness. But every mathematician knows that it is now practicable to provide a large and diversified body of genuinely graduate mathematical instruction for which the calculus is strictly not prerequisite.

Fortunately it is just the material that is thus available which is in itself best suited for the avocational instruction we are contemplating. As the calculus is not to be presupposed it goes without saying that this subject must find a place in the scheme. For evidently an advanced mathematical course devised and conducted in the interest of general intelligence can not be silent respecting "the most powerful weapon of thought yet devised by the wit of man." Technique is not sought and can not be given. The subject is not to be presented as to undergraduates. For the most part these gain facility with but little comprehension. It is to be presented to mature and capable students who seek, not facility, but understanding. Their desire is to acquire a general conception of the nature of the calculus and of its place in science and

the history of thought—such a conception as will at least enable them as educated men to mention the subject without a feeling of sham or to hear it mentioned without a feeling of shame. A few well-considered lectures should suffice. At all events it would not require many to show the historical background of the calculus, to explain the nascence and nature of the scientific exigencies that gave it birth, to make clear the concepts of derivative and integral as the two central notions of its two great branches, and to present a few simple applications of these notions to intelligible problems of typical significance. Even the idea of a differential equation could be quickly reached, the nature of a solution explained, and simple examples given of physical and geometric interpretations. As to the range and power of the calculus, a sense and insight can be given, in some measure of course by a reference to its literature, but much more effectively by a few problems carefully selected from various fields of science and skillfully explained with a view to showing wherein the methods of the calculus are demanded and how they serve. Is not all this elementary and undergraduate? In point of nomenclature, yes. It is not necessary, however, to let words deceive us. We teach whole numbers to young children, but even Weierstrass was not aware of the logico-mathematical deeps that underlie cardinal arithmetic.

The calculus, however, is hardly the topic with which the course would naturally begin. A principal aim of the course should be to show what mathematics, in its inner nature, is—to lay bare its distinctive character. Its distinctive character, its structural nature, is that of a "hypothetico-deductive" system. Probably, therefore, it would be well to begin with an exposition of the nature and function of postulate systems and of the great rôle such systems have always played in the science, especially in the illustrious period of Greek mathematics and even more consciously and elaborately in our own time. It is plain that such an exposition can be made to yield fundamental insight into many matters of interest and importance not only in mathematics, but in logic, in psychology, in philosophy, and in the methodology of natural science and general thought. The material is almost superabundant, so numerous are the postulate systems that have been devised as foundations for many different branches of geometry, algebra, analysis, *Mengenlehre* and logic. A general survey of these, were it desirable to pass them all in review, would not be sufficient. It will be necessary to select a few systems of typical importance for minute examination with reference to such capital points as convenience, simplicity, adequacy, independence, compatibility and categoricalness. The necessity and presence of undefined terms in any and all systems will afford a suitable opportunity to deal with the highly important, much neglected and little understood subject of definition, its nature, varieties and function, in light of the recent literature, especially the suggestive handling of the matter by Enriques in his "Problems of Science." A given system once thus examined, the easy deduction of a few theorems will suffice to show the possibility and the process of erecting upon it a perfectly determinate and often imposing superstructure. And so will arise clearly the just conception of a mathematical doctrine as a body of thought composed of a few undefined together with many defined ideas and a few primitive or postulated propositions with many demonstrated ones, all concatenated and welded into a form independent of will and temporal vicissitudes. Revelation of the charm of the science will have been begun. A

new revelation will result when next the possibility is shown of so interchanging undefined with defined ideas and postulates with demonstrated propositions that, despite such interchange of basal with superstructural elements, the doctrine as an autonomous whole will remain absolutely unchanged. But this is not all nor nearly all. It is only the beginning of what may be made a veritable apocalypse. Of great interest to any intellectual man or woman, of very great interest to students of logic, psychology, or philosophy, should be the light which it will be possible in this connection to throw upon the economic rôle of logic and upon the constitution of mind or the world of thought. I refer especially to the recently discovered fact that in interpreting a system of postulates we are not restricted to a single possibility, but that, on the contrary, such a system admits in general of a literally endless variety of interpretations; which means, for such is the make-up of our *Gedankenwelt*, that an infinitude of doctrines, widely different in respect of their psychological character and interest, have nevertheless a common form, being isomorphic, as we say, logically one, though spiritually many, reposing on a single base. And how foolish the instructor would be not to avail himself of the opportunity of showing, too, in the same connection, how various mathematical doctrines that differ not only psychologically, but logically also, are yet such that, by virtue of a partial agreement in their bases, they intersect one another, owning part of their content jointly, whilst being, in respect of the rest, mutually exclusive and incompatible. If, for example, it be some Euclidean system that he has been expounding, he will be able readily to show upon how seemingly slight changes of base there arise now this or that variety of non-Euclidean geometry, now a projective or an inversion geometry or some species or form of higher dimensionality. I need not say that analogous phenomena will in like manner present themselves in other mathematical fields. And it is of course obvious that as various doctrines are thus made to pass along in deliberate panorama it will be feasible to point out some of their salient and distinctive features, to indicate their historic settings, and to cite the more accessible portions of their respective literatures. Naturally in this connection and in the atmosphere of such a course the question will arise as to why it is that, or wherein, the hypothetico-deductive method fails of universal applicability. So there will be opportunity to teach the great lesson that this method is not rudimentary, but is an ideal, the ideal of intellect and science; to teach that mathematics is but the name of its occasional realization; and that, though the ideal is, relatively speaking, but seldom attained, yet its lure is universal, manifesting itself in the most widely differing domains, in the physical and mechanical assumptions of Newton, in the ethical postulates of Spinoza, in our federal constitution, even in the ten commandments, in every field where men have sought a body of principles to serve them as a basis of doctrine, conduct or achievement. And if it shall thus appear that mathematics is very high-placed as being, in respect of its method and its form, the ideal and the lure of thought in general, the fault must be imputed, not to the instructor, but to the nature of things.

In all this study of the postulational method the impression will be gained that the science of mathematics consists of a large and increasing number of more or less independent, somewhat closely related and often interpenetrating branches, constituting, not a jungle, but rather an immense, diversified, beautifully ordered for-

est; and that impression is just. At the same time another impression will be gained, namely, that the various branches rest, each of them, upon a foundation of its own. This impression will have to be corrected. It will have to be shown that the branch-foundations are not really fundamental in the science but are, literally and genuinely, component parts of the superstructure. It will have to be shown that mathematics as a whole, as a single unitary body of doctrine, rests upon a basis of primitive ideas and primitive propositions that lie far below the so-called branch-foundations and, in supporting the whole, support these as parts. The course will, therefore, turn to the task of acquainting its students with those strictly fundamental researches which we associate with such names as C. S. Peirce, Schroeder, Peano, Frege, Russell, Whitehead and others, and which have resulted in building underneath the traditional science a logico-mathematical sub-structure that is, philosophically, the most important of modern mathematical developments.

It must not be supposed, however, that the instruction must needs be, nor that it should preferably be, confined to questions of postulate and foundation, and I will devote the remainder of the time at my disposal to indicating briefly how, as it seems to me, a large or even a major part of the course may concern itself with matters more traditional and more concrete.

Any one can see that there is an abundance of available material. There is, for example, the history and significance of the great concept of function, a concept which mathematics has but slowly extracted and gradually refined from out the common content and experience of all minds and which on that account can be not only defined precisely and intelligibly to such laymen as are here concerned, but can also be clarified in many of its forms by means of manifold examples drawn from elementary mathematics, from the elements of other sciences, and from the most familiar phenomena of the work-a-day world.

Another available topic is the nature and rôle of the sovereign notion of limit. This, too, as every mathematician knows, admits of countless illustration and application within the radius of mathematical knowledge here presupposed. In this connection the structure and importance of what Sylvester called "the Grand Continuum," which so many scientific and other folk talk about unintelligently, will offer itself for explanation. And if the class fortunately contain students of philosophic mind, they will be edified and a little astonished perhaps when they are led to see that the method and the concept of limits are but mathematicized forms of a process and notion familiar in all domains of spiritual activity and known as idealization. Not improbably some of the students will be sufficiently enterprising to trace the mentioned similitude in some of its manifestations in natural science, in psychology, in philosophy, in jurisprudence, in literature and in art.

I have not mentioned the modern doctrine variously known as *Mengenlehre*, *Mannigfaltigkeitslehre*, the theory of point-sets, assemblages, manifolds or aggregates: a live and growing doctrine in which expert and layman are about equally interested and which, like a subtle and illuminating ether, is more and more pervading mathematics in all its branches. For the avocational instruction of lay students of "maturity and power" how rich a body of material is here, with all its fascinating distinctions of discrete and continuous, finite and infinite, denumerable and non-denumerable, orderless, ordered, and well-ordered, and with its teeming host of near-

lying propositions, so interesting, so illuminating, often so amazing.

Finally, but far from exhausting the list, it remains to mention the great subjects of invariants and groups. Both of them admit of definition perfectly intelligible to disciplined laymen; both admit of endless elementary illustration, of having their mutual relations simply exemplified, of being shown in historic perspective, and of being strikingly connected, especially the notion of invariance, with the dominant enterprise of man: his ceaseless quest for the changeless amid the turmoil and transformation of the cosmic flux.

CASSIUS J. KEYSER
COLUMBIA UNIVERSITY

PRELIMINARY REPORT ON A SHALER MEMORIAL STUDY OF CORAL REEFS

A LIBERAL grant from the Shaler Memorial Fund of Harvard University, supplemented by a generous subsidy from the British Association for the Advancement of Science with an invitation to attend its meeting in Australia last August as a foreign guest, enabled me to spend the greater part of the year 1914 in visiting a number of islands in the Pacific Ocean with the object of testing various theories that have been invented to account for coral reefs. Thirty-five islands, namely, Oahu in Hawaii, eighteen of the Fiji group, New Caledonia of which the entire coast line was traced, the three Loyalty islands, five of the New Hebrides, Rarotonga in the Cook group, and six of the Society islands, as well as a long stretch of the Queensland coast inside of the Great Barrier reef of northeastern Australia, were examined in greater or less detail. A brief statement of my results has been published in the *Proceedings of the National Academy of Sciences* for March, 1915. A full report will appear later, probably in the *Bulletin of the Museum of Comparative Zoology* at Harvard College. The general conclusions reached are here briefly summarized.

Any one of the eight or nine theories of coral reefs will satisfactorily account for the visible features of sea-level reefs themselves, provided the postulated conditions and processes of the invisible past are accepted: hence a study of the visible features of the reefs alone can not lead to any valid conclusion. Some independent witnesses must be interrogated, in the hope of detecting the true theory. The only witnesses, apart from sections obtained by deep and expensive borings, available for sea-level reefs are the central islands within oceanic barrier reefs, or the mainland coast within a continental barrier reef. The testimony of these witnesses has been too largely neglected, apparently because most investigators of coral reefs have been zoologists, little trained in the physiography of shore lines. Elevated reefs afford additional testimony in their structure and in the relation of their mass to its foundation; but these witnesses also have been insufficiently considered, perhaps because most investigators of reefs have, as zoologists, been little trained in structural geology; hence it seemed desirable to give as much time as possible on the Pacific islands to questioning the independent witnesses above designated, rather than to the study of the reef themselves.

The testimony of the first group of witnesses—the central islands of barrier reefs—convinced me that Darwin's theory of subsidence is the only theory competent to explain not only the development of barrier reefs from fringing reefs, but also the shore-line features of the central (volcanic) islands within such reefs; for the embayment of the central islands testify emphatically to subsidence, as Dana long ago pointed out: thus my results in the study of this old problem of the Pacific agree with those of several other recent students, especially Andrews, Hedley and Taylor of Australia, and Marshall of New Zealand. Darwin's theory of subsidence also gives by far the most probable explanation of atolls; for it is unreasonable to suppose that a subsidence of the ocean bottom should occur only in regions where the central islands of barrier reefs are present to attest it, and not in neighboring regions where reefs of identical appearance,

but without a central island, are given another name.

The testimony of the second group of witnesses—massive elevated reefs such as occur on certain Fiji Islands—convinced me that Darwin's theory of subsidence gives the only satisfactory explanation of the origin of such reefs also; for their limestones rest unconformably on the normally eroded surface of a preexistent foundation. The erosion of the foundation surface shows that it stood above sea-level before the reef was deposited upon it; and the occurrence of the reef shows that the eroded foundation subsided to receive its marine cover. Only after this subsidence was the compound mass uplifted. The mere occurrence of elevated reefs above sea level does not for a moment prove that they were formed during the emergence of their foundation.

All the still-stand theories of barrier reefs—that is, all the theories which involve a fixed relation of the reef foundation to the sea level during the formation of the reef mass—are excluded by evidence of submergence found in the embayed shore lines of the central islands within barrier reefs. It may seem overbold thus at a stroke to set aside several well-known theories, accepted by experienced observers; and so indeed it would be if these observers had discussed the features of the embayed central islands and had explicitly shown that their embayments are not due to submergence, but to some other cause. It is, however, a regrettable fact that the observers who adopted one or another of the still-stand theories took, like Darwin himself, practically no account of the embayed central islands, essential as the testimony of these islands is in the solution of the coral-reef problem. Such neglect is all the more remarkable in view of the clear statement, long ago published by Dana, regarding the pertinence and the value of the testimony afforded by the central islands of barrier reefs.

The glacial-control theory of coral reefs, recently elaborated by Daly with special reference to the lagoons of atolls, will not hold for barrier reefs. This theory assumes that no subsidence of the reef foundations took place, and explains the lagoon floors of atolls as platforms abraded across preglacial sea-level reef-masses by the lowered and chilled sea of the glacial period after the corals were killed; the preglacial reef-masses having been formed by upward or outward growth on their still-standing foundations. It then explains the encircling reefs which now surround the lagoons as having been built up while the sea was rising and warming in postglacial time. But if the broad lagoons of large atolls, 20 or 30 miles in diameter, were thus formed, the central islands within narrow-lagoon barrier reefs should be cliffed all around their shore line, and they are not. Furthermore, this theory explains the embayments of central islands within barrier reefs as occupying new-cut valleys that were eroded during the glacial period of lowered sea level; but if this were the case, the new-cut valleys should be prolonged upstream from the embayment heads as incisions in the floors of preglacial valleys, thus producing a "valley-in-valley" landscape; and this is not true in any one of the hundreds of embayments seen during the past year. Furthermore, many of the embayments are so wide that, if they were opened by slow subaerial processes, all the spur ends ought to have been well cliffed by the sea; yet, as above stated, they are not cliffed. Finally many of the embayments are too wide to have been eroded during the last glacial epoch, or even during all the glacial epochs of the entire glacial period, if the valleys of the formerly glaciated volcanoes of central France are taken as standards of the amount of erosion that could be accomplished in such masses during such intervals of time. The glacial-control theory thus proves incompetent to explain barrier reefs, and it is therefore held to be generally incompetent to explain atolls also; it may have more importance on the borders of the coral zone, where the corals would most likely have been killed during the glacial period: the Marquesas Islands promise interesting results in this connection. The glacial-control theory has its greatest importance in conjunction with Darwin's theory of subsidence, for submergence during subsidence may have been

almost neutralized by the lowering of the sea-level during the oncoming of a glacial epoch, and at such a time coral reefs would broaden and lagoons would become shallow; but with the passing of a glacial epoch the return of ice-sheet water to the ocean would accelerate the submergence due to subsidence, and at such a time coral reefs might be more or less completely drowned: thus the discontinuity of certain reefs on so-called "platforms" may be explained.

All the phenomena which testify to the formation of coral reefs on subsiding foundations can be equally well explained by the assumption of a rise of the ocean surface around or over fixed foundations: but a rise of the ocean surface in any coral-reef region demands a rise of the whole ocean surface; and if the coral-reef foundations are to stand still, a rise of the whole ocean surface can be explained only as the diminished result of a greater rise of the ocean floor in some non-coral-reef region. The conditions involved in this alternative for the simple theory of local subsidence are so extravagantly improbable that, as soon as they are explicitly defined, they must be rejected.

No absolute demonstration of the origin of coral reefs, or, for that matter, of any other geological structure, is possible: the most that can be hoped for is a highly probable conclusion. The conclusions announced above in favor of Darwin's theory are believed to have about the same order of probability as that usually accepted as "proof" in geological discussions.

A number of local conclusions may be briefly announced as follows:

The elevated reef along the south coast of Oahu, Hawaii, was formed during or after a sub-recent period of subsidence, for its limestones enter well-defined valleys that must have been eroded when the island stood higher than now, before the reef-limestones were deposited in them.

The Fiji group has suffered various movements of subsidence and elevation by which its many islands were affected in unlike ways. Elevation has taken place at different times in different islands, for some of the elevated reefs are elaborately dissected, others are very little dissected, and still others remain at sea-level. The embayments due to the latest subsidence on the larger islands, Viti Levu and Vanua Levu, are now largely filled with delta plains. All the reefs, those now elevated as well as those at sea-level, appear to have been formed during periods of subsidence, the evidence afforded by the elevated reefs of Vanua Mbalavu, Mango and Thithia, being especially significant on this point. The medium-sized island of Taviuni has few visible reefs, because its flanks and shores are flooded by sheets of recent lava. The small island of Wakaya seems to be a tilted block of lava beds, not a dissected volcano.

The extensive barrier reef of New Caledonia has grown up during a recent subsidence by which that long and maturely dissected island has been much reduced in size and elaborately embayed; but unlike most encircled islands this one was strongly cliffed around its southeastern end and along much of its northeastern side before the recent subsidence took place.

The two southeastern members of the Loyalty group, Maré and Lifu, are former atolls, evenly unlifted about 300 feet: Maré shows a small hill of volcanic rock in the center of its limestone plateau or elevated lagoon floor. Uvea, the northwestern of the three Loyalty Islands, is a slightly tilted atoll; its eastern side shows an uplifted reef in crescentic form, 100 or more feet high at the middle of its crescent, and slowly descending to sea-level at its horns; the tilted lagoon floor slowly deepens westward and is enclosed by disconnected, upbuilt reef-islands.

The New Hebrides show signs of uplift in their elevated reefs, and of depression in their embayments. There is some evidence that certain uplifted fringing reefs on the island of Efaté, near the center of the group, were formed during pauses in a subsidence that preceded their uplift, and not during pauses in their uplift as inferred by Mawson. The narrowness of the lagoons enclosed by the barrier reefs that encircle certain strongly embayed islands in this group may be explained by supposing alternations of slow and rapid subsi-

dence, so that the earlier-formed reefs, which began to grow when the subsidence was slowly initiated, were drowned when it was later accelerated; and new reefs, thereupon begun on the shore line of that time would after a second period of slow subsidence stand near the present shore line, though the shore line is strongly embayed because the total subsidence has been large. The absence of reefs around the island of Ambrym is due to its abundant eruptions in recent time, the latest one being in December, 1913; scattered corals were seen growing on one of its sea-cliffed lava-streams, thus illustrating the initial stage of a fringing reef.

The Great Barrier reef of Australia, the largest reef in the world, with a length of some 1,200 miles and a lagoon from 15 to 70 or more miles wide, has grown upward during the recent subsidence by which the Queensland coast has, after a long period of still-stand, been elaborately embayed, as was pointed out by Andrews in 1902. A very recent uplift of ten feet has occurred, as was long ago noted by Jukes. There is reason for believing that a broadened reef-plain, with extensive land-fed deltas along the continental margin, had been formed before the recent subsidence took place; and it is this broadened reef, now submerged, that is thought to form the "platform" on which the Great Barrier reef has grown up. Guppy's suggestion that the platform or "submarine ledge" is due to marine abrasion before coral reefs were established here and that no subsidence has taken place can not be accepted. It is highly probable that the well-attested recent subsidence was due to a gentle flexure, by which the off-shore sea-bottom was bent down; and if so, the coastal submergence will give much too small a measure of the thickness of the distant barrier reef. In this respect the Great Barrier reef along the shore of a continent differs significantly from smaller barrier reefs around oceanic islands, in which the subsidence of the island and its reef are essentially uniform.

A few hours on shore at Raretonga, the southernmost member of the Cook group, sufficed to show that extensive embayments formerly entering its elaborately carved mass are now occupied by delta plains and perhaps in part by slightly elevated reef- and lagoon-limestone.

Five islands of the Society group exhibit signs of recent subsidence in their intricately embayed shore lines, as has lately been announced by Marshall. A sixth, the cliff-rimmed island of Tahiti, the largest and youngest of the group, has suffered moderate subsidence after its cliffs were cut, but the resulting bays are now nearly all filled with delta plains which often advance into the narrow lagoon; hence a pause or still-stand has followed the latest subsidence. All the barrier reefs of this group appear to have been formed during the recent subsidence that embayed their central islands.

W. M. Davis

Harvard University

SCIENTIFIC NOTES AND NEWS

Dr. Richard P. Strong, professor of tropical diseases at the Harvard Medical School, has been appointed leader of the American Red Cross Sanitary Commission, which will assemble in Salonica about the middle of next month and proceed to the districts of Servia and Austro-Hungary which are stricken with epidemics of typhus, cholera and other contagious diseases. The commission will be supported by the Red Cross and the Rockefeller Foundation. Dr. Strong has already sailed for Greece, and the rest of the expedition will sail by the end of this month. It includes Dr. Thomas W. Jackson, of Philadelphia; Dr. Hans Zinsser, professor of bacteriology, Columbia University; Dr. Andrew W. Sellards, Dr. George C. Shattuck and Dr. Francis B. Grinnell, of the Harvard Medical School. Dr. Nicolle, the French expert on typhus, has been invited to cooperate with the commission. Mr. Charles S. Eby, of Washington, lately connected with the United States Immigration service, is disbursing officer and secretary for the commission.

The Rockefeller Foundation has made comprehensive plans for improving medical and hospital conditions in China. These are based

on the report of the special commission sent by the foundation to China. To carry out this work the foundation has established a special organization to be called the China Medical Board of the Rockefeller Foundation, constituted as follows: John D. Rockefeller, Jr., chairman; Wallace Buttrick, director; Harry Pratt Judson, Frank J. Goodnow, Dr. Simon Flexner, Jerome D. Greene, John R. Mott, Dr. William H. Welch, Wickliffe Rose, Starr J. Murphy, Dr. Francis W. Peabody and Frederick T. Gates. E. C. Sage is secretary of the board, and Roger S. Greene is to be the resident director in Pekin. The plan outlined by the commission looks to the development of medical education in China as the first step. With a view to building up a body of Chinese medical men able to teach medical science, the foundation has decided to establish six fellowships, each of $1,000 gold a year and traveling expenses, to enable Chinese graduates to study abroad. Six fellows have been appointed, one of whom is already in this country.

THE fifth annual award of the Willard Gibbs Medal, founded by William A. Converse, of Chicago, has been made to Arthur A. Noyes, director of the research laboratory of physical chemistry, Massachusetts Institute of Technology. Dr. Noyes in receiving the medal will address the Chicago Section of the American Chemical Society upon the evening of April 16, his medal address being "A System of Qualitative Analysis including nearly all the Metallic Elements." The recipient of this medal is determined by a jury of twelve, six of whom only can be members of the Chicago section, those outside the section being Alexander Smith, W. A. Noyes, W. H. Walker, T. W. Richards, Leo Baekeland and W. F. Hillebrand. Previous awards of this medal have been to Arrhenius, T. W. Richards, Baekeland and Remsen.

PROFESSOR ROBERT HALLOWELL RICHARDS was given a complimentary dinner on March 18 by the Mining and Metallurgical Society of America, the feature of which was the presentation of the gold medal of the society by the president, William R. Ingalls, former student under Professor Richards at the Massachusetts Institute of Technology. The banquet was in the Chemists' Club, New York, with a distinguished gathering of representative metallurgists from various parts of the country. The speakers besides Mr. Ingalls and Professor Richards were: W. L. Saunders, president of the American Institute of Mining Engineers; Charles W. Goodale, general manager of the Boston and Montana Department of the Anaconda Copper Mine; F. A. Lidbury, president of the American Electro-Chemical Society, and David H. Browne, metallurgical expert of the International Nickel Company.

DR. J. WILLIAM WHITE, professor emeritus of surgery and one of the trustees of the University of Pennsylvania, expects to enter the American Ambulance Service in Paris during the coming summer, taking with him a number of surgeons, physicians and nurses from the University of Pennsylvania staff.

THE following have been selected by the council of the Royal Society to be recommended for election into the society: Professor Frederick William Andrewes, Professor Arthur William Conway, Mr. Leonard Doncaster, Mr. John Evershed, Dr. Walter Morley Fletcher, Professor Arthur George Green, Mr. Henry Hubert Hayden, Dr. James Mackenzie, Professor John Cunningham McLennan, Dr. Arthur Thomas Masterman, Professor Gilbert Thomas Morgan, Dr. Charles Samuel Myers, Mr. George Clarke Simpson, Mr. Alan A. Campbell Swinton, and Mr. Arthur George Tansley.

To Surgeon-General William C. Gorgas has been awarded the Louis Livingston Seaman medal for progress and achievement in the promotion of hygiene and the mitigation of occupational disease.

AT the thirty-third annual dinner of the faculty of medicine of McGill University held in Montreal on February 13, Dr. Lewellys Franklin Barker, of the Johns Hopkins University, was the guest of honor.

PROFESSOR GEORGE PEGRAM, of the department of physics of Columbia University, has been elected president of the Columbia chapter of the Sigma Xi.

Dr. Charles H. T. Townsend has been elected the first honorary member in the New York chapter of the Alpha Mu Pi Omega Medical Fraternity.

Professor A. Looss, formerly connected with the school of medicine, Cairo, Egypt, has retired from that position. His present address is Stephanstrasse 18, Leipzig, Germany.

Dr. J. C. Bose, who has been lecturing in the United States on physiological botany, sailed from San Francisco for the Orient on March 20.

Dr. W. J. Hussey, professor of astronomy at the University of Michigan and director of the observatory, has returned to Ann Arbor, after having spent the past six months at La Plata University in South America.

News has been received from the University of Pennsylvania's Amazon expedition through its director, Dr. W. C. Farrabee. It is the first news that has come through in four months. Dr. Farrabee reports that he has spent three months at work in the interior, where he has been successful in getting much information and many specimens. He further states that he has just started for the highlands on the borders of Bolivia, Peru and Brazil, from which he had to turn back last August.

Professor William Trelease, of the department of botany of the University of Illinois, has been granted leave of absence from the university until May 1, for a botanical expedition to Guatemala, Central America.

Dr. Julius Stieglitz, professor of chemistry and director of analytical chemistry in the University of Chicago, has accepted an invitation to give courses in chemistry at the University of California during the summer term that begins June 21 and closes on August 1. Professor Stieglitz will give a seminar on special topics in organic chemistry and also a college course in organic chemistry.

On March 3, Professor E. E. Barnard, director of the Yerkes Observatory, lectured before the California chapter of the Sigma Xi upon the subject: "Some of the Visible Results of Astronomical Photography." The lecture was illustrated by a remarkable series of astronomical photographs.

Dr. Leland O. Howard delivered a lecture on "Insects and Disease" before the biological club and students of the medical department of Georgetown University, Washington, D. C., on March 11.

Dr. L. A. Bauer gave an illustrated lecture, on March 15, at Smith College, Northampton, under the auspices of the Physics Club, entitled "Following the Compass."

Professor Dayton C. Miller, of the Case School of Applied Science, lectured, on March 4 and 5, at the State University of Iowa. His subjects were (1) "The Science of Musical Sounds" and (2) "The Physical Characteristics of Vowels." Professor Miller also addressed the seminar of the department of physics on some of the more technical parts of his investigations. Professor C. G. Derick, of the University of Illinois, delivered two lectures at the university on March 13. The first was on the subject "The Teacher in Research." The second was upon the study of valence through ionization and dealt largely with Professor Derick's own work.

Dr. Otis W. Caldwell, professor in the University of Chicago, recently spent several days at the Kansas State Agricultural College, where he delivered several lectures to the students and scientific organizations of the college.

Dr. Frederick Winslow Taylor, of Philadelphia, past president of the Society of Mechanical Engineers, known for his inauguration of methods of "scientific management," died on March 21 at the age of sixty-nine years.

It is announced that Dr. Philip Beck, head of the Austrian Army Medical staff, recently died of typhus fever.

Dr. F. A. Bather, of the British Museum, writing in the *Museum Journal* of February, 1915, states that some international scientific activities continue between the countries now at war. Thus the German collaborators of the International Catalogue of Scientific Literature continue to send their manuscript to the

central office in London, while the members of the International Commission on Zoological Nomenclature still record their votes without distinction of country. The British government also permits a limited import of scientific books from Germany and Austria.

A CABLEGRAM to the daily papers was quoted in the issue of SCIENCE of December 25, to the effect that the trained horses of Elberfeld had been requisitioned for an artillery battery and that they had been killed on the battlefield in Flanders. Fortunately this report has proved to be untrue. According to the *Frankfurter Zeitung* of January 22, Herr Krall, the owner of the horses, has written to that paper to the effect that they are safe and well in the hands of a competent horseman, although the experiments upon them are in abeyance during the war.

SIR CHARLES A. PARSONS, the distinguished engineer, has given £5,000 to the Royal Institution, London, for the general purposes of the institution.

THE thirty-seventh annual meeting of the American Library Association will be held at Berkeley, Calif., on June 30.

THE eighth annual meeting of the American School Hygiene Association will take place in the city of San Francisco, June 25–26, 1915. Arrangements for this meeting are being made through the organization committee of which Professor Lewis M. Terman, Stanford University, Stanford, Calif., is chairman. Professor Terman is also chairman of the program committee. The influence of the American School Hygiene Association was very largely responsible for the great success of the Fourth International Congress on School Hygiene which was held in the city of Buffalo in the summer of 1913. It is hoped that the general interest stimulated by this International Congress may be productive of a large and an effective meeting in San Francisco.

UNIVERSITY AND EDUCATIONAL NEWS

WE have received the following telegram signed by five professors of the University of Utah:

"Fourteen members of the University of Utah faculty have resigned—Cummings, dean of art and science; Holman, dean of law school; six department heads—Roylance, history; Ebaugh, chemistry; Vorhies, biology; Mattill, physiology and physiological chemistry; Peterson, psychology, and six others—Butler and Blood, English; Sharp, histology; Hedger, registrar; Stephens, law; Thiel, German. Of the eleven members of the American Association for the Advancement of Science in the University of Utah, but three remain. The immediate cause is the recent dismissal of Knowlton, in physics, Wise, in German, and Bing and Snow, in English, and the demotion of Professor Marshall, for twenty-three years head of the English department and Reynolds, professor of English. For specious and fluctuating reason, without heed to petition from students, faculty, alumni and others, the president refuses an investigation and has been upheld by the board of regents. This is the culmination of a policy of repression that has been growing steadily in the past two or three years, resulting in an entire lack of mutual confidence. We believe this should be known at once for the safeguarding of our successors in the profession. They should come only with their eyes open."

THE dedication of the new Julius Rosenwald Hall in connection with the ninety-fourth convocation of the University of Chicago was held on the morning of March 16. The program included addresses by President Harry Pratt Judson, Professor Rollin D. Salisbury, head of the department of geography and dean of the Ogden Graduate School of Science; Professor Thomas Chrowder Chamberlin, head of the department of geology, and seven alumni of the university who took their degrees in the departments which will use the new building: Eliot Blackwelder, A.B., '01, Ph.D., '14, professor of geology, the University of Wisconsin; Frank Walbridge De Wolf, S.B., '03, director of the State Geological Survey of Illinois; William Harvey Emmons, Ph.D., 1904, professor of mineralogy and geology, the University of Minnesota, director of

the Geological Survey of Minnesota; Wallace Walter Atwood, S.B., '97, Ph.D., 1903, professor of physiography, Harvard University; Edwin Bayer Branson, Ph.D., 1905, professor of geology, the University of Missouri; Ermine Cowles Case, Ph.D., 1896, professor of historical geology and paleontology, the University of Michigan; George Frederick Kay, Ph.D., '14, professor of economic geology and petrology of the State University of Iowa, director of the Geological Survey of Iowa. The exercises were held in the lecture room of the new hall, and the entire building, with its equipment, was then placed on exhibition.

A NEW site for the Fuertes Observatory of Cornell University has been approved by the committee on buildings and grounds, on the recommendation of a subcommittee which had considered the matter in consultation with Dean Haskell of the College of Civil Engineering. The observatory was torn down last fall to make room for the new drill hall. It is to be erected on the summit of a knoll just north of Beebe Lake, near the east end of the lake. The site is on a part of the Kline farm which was purchased by the university a year or two ago. It is just 900 feet above sea level.

AT a meeting of the Yale corporation on March 15, Dr. John Zeleny, professor of physics at the University of Minnesota, was appointed professor in the Sheffield School to succeed Professor Charles S. Hastings. Dr. J. M. Slemons, professor of obstetrics and gynecology in the University of California, was appointed to the corresponding chair in the medical school. Dr. Hiram Bingham was promoted to be professor of Latin-American history; Dr. T. S. Taylor, now instructor, was made assistant professor of physics in the college; Dr. A. F. Holding, of the Cornell Medical School, was made assistant professor of radiography in the medical school; Dr. A. M. Bateman, of Queen's College, was made instructor in biology, and Mr. H. L. Bruce, of the University of California, instructor in engineering.

DR. HERBERT M. EVANS, associate professor of anatomy in the Johns Hopkins University and research associate in the department of embryology of the Carnegie Institution of Washington, has accepted a call to the professorship in anatomy and directorship of the department of anatomy of the University of California. Dr. Evans will assume his new duties on July first.

DR. W. V. BINGHAM, assistant professor of psychology and education at Dartmouth College and for the past three years director of the summer session, has accepted appointment as professor of psychology in the Carnegie Institute of Technology at Pittsburgh. Dr. Bingham will not leave Hanover until September, after the summer session.

AMONG new promotions at the University of Chicago are the following: To a professorship: Henry Chandler Cowles, of the department of botany, Charles Joseph Chamberlain, of the department of botany; Otis William Caldwell, of the college of education (botany). To an assistant professorship: J. Harlen Bretz, of the department of geology; George William Bartelmez, of the department of anatomy; Elbert Clark, of the department of anatomy. To an instructorship: Harold S. Adams, of the department of physiology.

DR. CHARLES KENNETH TINKLER has been appointed to the readership in chemistry tenable in the home science department of King's College for Women, London. He has been a research student of the University of Edinburgh, and since 1904 lecturer and demonstrator in chemistry in the University of Birmingham.

DISCUSSION AND CORRESPONDENCE

CONRAD RÖNTGEN

THE twenty-seventh of March marks the seventieth birthday of Conrad Röntgen, an event which was to have been jointly commemorated by physicists of all nationalities, especially English, French and German, the three which have contributed most markedly to the development of the new era in physics—an era which may with some reason be dated from the announcement in January, 1896, of the discovery of X-rays.

But when last summer the spirit of this new world which has been created by modern science, the spirit of reason, of cooperation, or internationalism, was submerged in the wave of blind nationalism which swept the world back a thousand years towards barbarism, when the crowning glory of science, the objective, impartial search for truth was forgotten, and prejudice and hate alone dictated the words and acts of men, then it was felt necessary to abandon the plans for the Röntgen celebration.

But here in America where, let us hope, the spirit and the method of science still find some advocates, it is fitting that on the twenty-seventh of March we bring honor and appreciation to the seventy-year-old author of one of the world's greatest discoveries—Conrad Röntgen.

R. A. MILLIKAN

UNIVERSITY OF CHICAGO,
March 18, 1915

THE CONTENTS OF A SHARK'S STOMACH

TO THE EDITOR OF SCIENCE: I have received from Mr. W. F. Cameron, of Zamboanga, P. I., a Stanford engineer, a photograph of a rare shark, *Rhinodon typicus*, a specimen about twenty feet long, taken on the island of Cebu. A notable feature about this shark, which has a very big mouth and small teeth, is that it had in its stomach 7 leggings, 47 buttons, 3 leather belts and 9 shoes. He had probably captured the cast-off garments of some company, otherwise the question arises—What became of the odd legging and the odd shoe?

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THE SCALED AMPHIBIA OF THE COAL MEASURES

THE preservation of scales among true Amphibia has been well known for many years, and their presence has been commented on by Huxley, Cope, Dawson and others. Recently the question of the crossopterygian ancestry of the Amphibia has received considerable support through the researches of Gregory, Watson, Broom and Williston, so that it will be of interest to state here the conditions of the scales among the few species of Amphibia from the Coal Measures which show these structures. Scales are known on several genera of diverse relationship and seem to have been present independent of any common ancestry. These structures, presently to be described, are true scales, and are not to be confused with osseous scutes and ventral scutellæ. These latter structures will be dealt with more fully in another place.

Small scales hexagonal in form have been observed in a branchiosaurian genus, *Micrerpeton*, from North America, though this discovery has not so far been confirmed on additional material, although known to occur in another genus, *Eumicrerpeton*. From the Coal Measures of Ohio come two scaled microsaurian genera, one of which is *Cercariomorphus*, described by Cope, though never figured. The scales in this genus do not show many of the fish characteristics, though they resemble remotely some of the more aberrant forms. The scales are dermal tubercles inserted in the skin, without any definite plan of imbrication, such as is common among the fishes, although the scales have a definite arrangement simulating the fishes. The pattern shows a remote resemblance to some of the early ganoids. They are, moreover, true scales, and as such possibly indicate one more link added to the already full chain of facts which ally the Amphibia and the fishes.

The other genus from Ohio possessing scales is imperfectly known, but was tentatively allied, some years ago, to the genus *Ichthyerpeton*, described many years ago by Huxley from the Coal Measures of Ireland. There is no assurance that the forms are so closely related. They both possess scales of a similar pattern and have an identical form of vertebra. The scales in the only known American species are so badly scattered that nothing can be said of their arrangement. Dawson's work on the scaled Amphibia of the Coal Measures of Nova Scotia is well known. He has figured and described very completely the scales of *Hylonomus*. They bear a great resemblance to the scales of *Cercariomorphus*.

The question now before us is whether the

scales of these few species of Coal Measures Amphibia are sufficiently fish-like to be of service in the derivation of the Amphibia from the fishes. One would think that they might be, and it is the intention of the writer to describe and illustrate these structures fully; clearly distinguishing between scales, osseous scutes and ventral scutellæ. These latter may be scale-like, but are always confined to the myomeres of the abdomen, thorax and throat. That some of the ventral scutellæ have a scale-like arrangement is certain, but this arrangement can be accounted for on other grounds. The writer is confident that the ventral scutellæ have an entirely different origin, ontogenetically and phylogenetically, from true scales.

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THE COTTON WORM MOTH IN 1912

An enormous migratory flight of the cotton worm moth, *Alabama argillacea* Hubn., was recently reported by Dr. A. P. Saunders[1] as occurring at Clinton, N. Y., on October 10, 1912, the moths swarming into town about 3 A.M. He states also that two or three days earlier a large invasion of the moths occurred at London, Ontario.

It is therefore of especial interest to note that another huge swarm, probably of the same wave of migration, appeared at Hanover, N. H., two days later than at Clinton, N. Y., viz., the early morning of October 12, 1912. Windows and doors of business houses that had been brightly illuminated during the night were literally covered in the morning with these handsome brown moths.

The facts, so far as they go, seem to warrant the conclusion, or at least the hypothesis, that a great wave of these insects from the cotton growing Gulf States was moving in a northeasterly direction at the rate of about 80–100 miles per night. This would require an average rate of flight of only 8–10 miles per hour. Continuing on the same course at the same rate the wave would have reached Augusta, and perhaps Bangor, Me., on October 14, though it is quite possible that the rather heavy rain that fell in New Hampshire on the night of the 12th and 13th may have delayed the flight or changed the direction of its course. Records from that region will be awaited with much interest. Clinton, N. Y., is roughly 300 miles due east of London, Ont., lat. 43° N. Hanover, N. H., is about 160 miles northeast of Clinton, and 43° 42′ N. The part of the wave front that passed through London, Ont., presumably passed considerably to the north of Clinton, if the moths were guided at all by the prevailing winds of October 9 in that vicinity, and traveled, as would be expected, in a northeasterly direction over the length of Lake Ontario.

In a case of this kind, in which winged creatures wander far from their native habitat, it is natural to suppose that the wind has played a prominent part in the dispersal, as when an occasional murre is driven inland by the storms of winter. So far as I have been able to learn, however, from a somewhat superficial examination of the records of the weather conditions of the time, I have found no evidence of any notable atmospheric disturbance sufficient to account for this apparently large and extensive migration. In Ontario and the northeastern states the moths would seem to have encountered only moderate southwest winds, followed on the 10th–12th by unsettled weather and variable winds of no great velocity.

It is impossible at present to say whether light, which has such a powerful control over the movements of butterflies and, to a more limited extent, of moths, was or was not an important factor in this case, but it is a matter worth considering.

This migratory wave seems to have passed to the north of Massachusetts, if one may judge from the scanty data at hand, though Professor Fernald[2] has reported that earlier in the season (Sept. 21–25, 1912) a few of these moths were taken in that state. He mentions a large invasion in 1911, during the last week in September, and another on October 17, 1914,

[1] Science, January 8, 1915.

[2] Science, November 27, 1914.

around Worcester, Mass., and, about the same time, in Pittsfield.

These sporadic and easily traceable migrations of the cotton worm moth, in the opinion of the writer, afford a rare opportunity, with the cooperation of many observers, for a thorough investigation into the causes of insect dispersal. Such an investigation would be likely to bring to light some important facts, of common interest to students of evolution and of economic entomology.

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SCIENTIFIC BOOKS

Sugar Analysis: For Cane-sugar and Beet-sugar Houses, Refineries and Experiment Stations and as a Handbook of Instruction in Schools of Chemical Technology. By FERDINAND G. WIECHMANN, Ph.D. New York, Jno. Wiley & Sons. Third edition. 8vo. Pp. xiii + 307. 7 figs. Cloth, $3.00.

The author "has endeavored to cast his material in a form in which it would prove most readily available in the several branches of the sugar industry," and has reduced repetition to a minimum. "The methods and means used in the analysis of sugar and in the analysis of materials used in sugar production, have first been fully discussed, and then specific analytical control of cane-sugar manufacture, of beet-sugar manufacture, and of refining, has been taken up for detailed consideration."

The first seven chapters are devoted to Properties of Sucrose; Instruments Used in Sugar Laboratories; Polariscopes and Accessories; Sucrose Determination by Optical Analysis; Sucrose Determination by Chemical Analysis; Sucrose Determination by Optical and Chemical Analysis; and, Constituents of Sugar Other Than Sucrose; the eighth chapter to Materials Used in the Sugar Industry, the ninth, tenth and eleventh chapters, respectively, to Analytical Control in Cane-sugar Manufacture; Analytical Control in Beet-sugar Manufacture; and, Analytical Control in Refineries. In the twelfth chapter, a Résumé of the Work of the International Commission for Uniform Methods of Sugar Analysis is given. Twenty well-selected sugar tables and the index to the volume occupy the last 70 pages.

The portions dealing with the properties of sucrose, instruments, polariscope and accessories, sucrose determination by optical methods, by chemical methods, by optical and chemical methods, and the constituents of sugar other than sucrose, are clear in definition without being overburdened with detailed description to be found in references cited. In some instances, however, more detailed directions would add value to the volume when being used for instructional purposes. For example, on page 123, in the direction for the determination of woody fiber, no precaution, such as covering the beaker with washed muslin, etc., is directed to prevent loss of portions of fiber in decanting, other than: "The water . . . is decanted carefully, in order to avoid any loss of the weighed sample."

On pages 71 and 178–179, in giving the method of Clerget, the author states that the use of subacetate of lead as a clarifying agent is not permissible, recommending, on page 71, specially prepared blood-carbon, and on pages 178–179 specially prepared bone-black, "if a decolorant must be used."

Some of the methods given in chapter 8, for the analysis of materials used in the sugar industry, could be substituted by more modern and expedient ones. That given on page 146, for the determination of calcium sulphide, could be substituted by the more expedient evolution method used in the steel and iron industry. On page 151, seventh line from the top, in the method for the determination of total phosphoric acid in phosphate paste, the direction, after making alkaline with ammonia and clearing with nitric acid, is: "Add about 10 grams of ammonium nitrate." This is neither necessary nor advisable, when the method of solution is that recommended at the top of the same page, viz., by nitric and hydrochloric acids. The rest of the method, as outlined on this page, could be substituted by that of the Association of Official Agricultural Chemists as given in Bulletin 107, Bureau of Chemistry. On page 153,

"the latent heat of steam formation" is given as 967, instead of 970.4. On page 154, the method given for the determination of moisture and volatile carbon in coal could be replaced by standard ones. On page 155, the author states that, from the data of the proximate analysis, "the calorific power of the coal can be *approximately* calculated by Lenoble's formula" which he gives. A description and instruction in the use of a standard calorimeter at this point would not be amiss. On page 158, under "Water," the direction is to dry total solids and the residue, before driving off organic and volatile matter, at 130 degrees Centigrade to constant weight, instead of at 103 degrees for one half hour. On page 162, the soap method for hardness is given, but no mention is made of the titration methods.

In the chapters on analytical control in cane-sugar factories, beet-sugar factories and refineries, the author tabulates the work involving control of sugar materials and products, indicating what determinations are necessary on each. He avoids repetition as much as possible by referring to the directions for analytical methods given in the chapters devoted to outlines and discussions. One would call attention to the direction for determination of sucrose in molasses, on page 181. Under Clerget, on this page the following is given: "The direct polarization and the polarization after inversion should be carried out on portions of one and the same solution; for this reason two or three times the normal weight of molasses should be dissolved in 500 c.c. of water. The determination is then carried out as previously directed." Doubtless he intends that the dilution should be to 500 c.c. instead of "dissolved in." Since in giving the method of Clerget on pages 71 and 178–179, it is stated that the use of subacetate of lead is not permissible, but if a decolorant must be used specially prepared blood-carbon or bone-black should be employed, the operator or student would refer to these directions when preparing his solution for the double polarization of molasses, thereby omitting clarification with lead compounds and subsequent deleading but resorting to decolorization with bone-black or blood-carbon, unless he perchance referred to the Meissel-Hertzfeld method as given in chapter 6, page 94, which he is hardly expected to do since this method is given and discussed in the chapter given to the determination of sucrose by optical and chemical methods and not to the determination by optical methods as Clerget calls for. Evidently the author would not recommend clarification of molasses with subacetate of lead when determining sucrose by the Clerget method.

Chapter 12 is an invaluable addition to the volume, as a résumé of the work of the International Commission is here given, which is not always at the hands of the chemist, either in the original transactions or in compilation. It is commendable that this so-important work is compiled and condensed in an available form.

The tables given are well selected and will meet the needs of the sugar analyst, except table 18 (that used in calculating the percentage of commercial sugar recovered from the sucrose in the massecuite as given by I. H. Morse), which is incomplete and would be of little service except in refineries.

The subject-matter of the volume is well correlated, repetitions are few, and the style and appearance of the book are good. Although criticism is here brought of some of the methods of analysis, as given in chapter 8, and attention called to the method for the preparation of the solutions in the determination of sucrose in molasses, and to the incompleteness of table 18, this work will be an addition to any technical library and of aid to the analyst experimenter and student, when working on commercial sugars and allied products and following routine analytical work in sugar houses and refineries.

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Electric Arc Phenomena. By Ewald Rasch. Translated from the German by K. Tornberg. New York, D. Van Nostrand Company. 1913. Pp. 194.

The introduction contains a discussion of the relative merits of the electromagnetic and

the electrodynamic theory of light in which the author demonstrates the ascendency of Wilhelm Weber over James Clerk Maxwell and predicts that "the explanations furnished by the electronic theory . . . contain the germs of future progress in electric-light engineering." The reasons for this prophecy, however, are not disclosed.

After explaining what an arc is, the conditions under which it is formed and the method of adjustment the author describes the physical and chemical properties of typical electrode materials and the process of manufacture of carbon electrodes. This is followed by a brief discussion of the theory of electrical discharges based upon the electronic theory. In the fifth chapter the author reviews some of the investigations made upon spark discharges between electrodes of different shapes in air. The treatment of this subject seems scant and antiquated in view of the many pertinent investigations made during the past ten years. The effect of gas pressure, humidity, temperature and kind of gas is not considered.

The most valuable contributions to the subject are made in the last three chapters. The sixth chapter has to do with the voltage and current conditions in the direct and alternating-current carbon arc lamp, the seventh with the distribution of energy in carbon arc lamps and vapor tubes, and the eighth with the relation between power and light emitted by plain and mineralized carbon arc lamps and vapor tubes.

The author confesses that some of his remarks are of purely didactic nature, and these digressions, although prohibitive of smooth development of the subject, contain many valuable suggestions. In expressing his disapproval of the term "watts per candle" the author has anticipated the recent suggestion of the term "lumens per watt." In remarking that "physiological effects can no more be expressed in mechanical horse-power than can, for instance, Beethoven's 'Ninth Symphony'" it would seem, in view of the measurements reported by our modern nutrition laboratories, that the author might have chosen a less vulnerable example. The text at times seems to rise above the subject, the discussion in places being supported by cosmogonic reflections and the fourth dimension.

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SPECIAL ARTICLES

LIGHT AND THE RATE OF GROWTH IN PLANTS

A STUDY of the development of about a hundred seed-plants in darkness in an equable temperature chamber from 1900–03 in the New York Botanical Garden gave foundation for the following statement:

> The failure of a large proportion of the forms examined to make an accelerated or exaggerated growth when freed from the influence of light, even when provided with an adequate food-supply, shows that light has no invariable or universal relation to increase in length, or thickness or to the multiplication or increase in volume of separate cells.[1]

Precision appliances for the measurement of illumination and of other environmental conditions in daylight were not available at that time, and it was therefore not possible to follow the contrasting reactions which accompanied illumination and shading of the large plants which were the subjects in the extended experiments. In one series, however, the peduncles and scapes of *Arisaema* nearing the end of their period of elongation showed in initial acceleration when light was totally excluded from the plants. This acceleration reached its maximum in twenty-four hours then decreased to a minimum equivalent to the original rate in about four times this period. The older plump assertion that "light retards growth" continued to be cited without modification by writers of text-books and compendiums. The few investigators who turned attention to the subject have been content with referring to such cyclopedias. Thus Blaauw[2] says, in discussing positive and negative photogrowth reactions:

[1] MacDougal, "Influence of Light and Darkness on Growth and Development," *Mem. N. Y. Bot. Garden*, 2, pp. 307, 308, 1903.

[2] "The Primary Photogrowth Reaction and the Cause of the Positive Phototropism in *Phycomyces nitens*," Kon. Akad. van Wetensch. te Amsterdam. Proc. of meeting, January 31, 1914.

With regard to the existence of a sharply defined reaction of this kind, practically nothing can be deduced from literature references, at least the general opinion about the influence of light on growth is completely at variance with these facts. In the first place so far as concerns the positive or negative influence of light, the general conception, supported by numerous facts, is that light exercises a retarding influence on growth.

Blaauw's results which are described in the paper mentioned above and in a later paper[3] confirm my original thesis that light does not exercise a flat or invariable effect on growth. Furthermore Blaauw's beautifully arranged experiments by which sporangiophores of the mould were exposed to illumination from four or eight sides, with controlled intensities, demonstrate that the first reaction of this organ to a sudden illumination is an accelerated rate of growth, followed by a gradual decrease from which a recovery is made to the original rate. It is to be seen that the general mode of change is similar to that of massive organs deprived of light as described above. American reviewers seem to have been equally ignorant of my earlier experiments, which had the force of rendering the older generalization invalid. Furthermore the indirect effect of light in conditioning differentiations of tissues and thus affecting growth-elongations was pointed out. Blaauw has made an important contribution by his experimental analysis of the action of light on such simple structures as the sporangiophore of a mould.

The elongation or enlargement of a cell or of any structure like that of the sporangiophore of *Phycomyces* may be taken as the expression of inequality between the extensibility of the cell material, and its membrane, and of some internal expanding or stretching force. The osmotic pressure of the contents of the vacuoles, or of solutions filling the protoplasmic interstices has hitherto been relied upon to furnish the necessary force of growth.

Borowikov has recently established a parallel between the growth of certain seedlings in known definite solutions and the hydratation of colloids in the same solutions. This author is therefore led to believe that the stretching force of growth is not osmotic but hydratation pressure, and he relegates osmotic pressure, turgidity and its corollaries to an inconsequential place in the entire matter.[4]

Several features of the growth and hydratation of cacti are not without importance in connection with any consideration of this matter. The researches of Richards and of Spoehr at the Desert Laboratory show that the acidity (malic and oxalic) of the sap of cylindropuntias and platypuntias decreases from its maximum at daybreak to a minimum at about 4 P.M. in the open. The decrease has been shown to be due to the conjoint disintegrating action of temperature and chiefly of light. The calibrations made by Mr. E. H. Long (paper now in press) brought out the fact that if small cylinders were cut from the bodies of these cacti in series beginning at daybreak and extending to the period of minimum acidity, the hydratation capacity of the pieces increases independently of osmotic pressure throughout the day and is greatest in those which have been taken from the plant at the time when collateral tests would indicate the lowest acidity.

Extensive auxanometric records of *Opuntia Blakeana* made chiefly in March and April show that the growth of the enlarging joints is at a minimum in the morning, with a rapid acceleration parallel with the rising temperature of the open, reaching a maximum about noon and then decreasing to a minimum before 3 P.M. The curves of decreasing acidity and increasing hydratation capacity are symmetrical through the range of acidity from N/10 to N/20 according to available data obtained from these plants, and would probably sustain a similar relation in weaker solutions if the acidity were reduced still further.

From the records cited above however it is to be seen that the acceleration of the rate of growth does not follow that of hydratation to its customary daily maximum. Whether this divergence is due to a shrinkage following a heightened water-loss is not yet known. An ample supply was available to the absorbing

[3] "Light und Wachstum," *Zeitschr. f. Botanik.*, Hft. 8, 1914.

[4] Borowikow, "Ueber die Ursachen des Wachstums der Pflanzen," *Biochem. Zeitschrift*, 48: pp. 230–46, 1913.

surfaces within a few cm. of the expanding masses of cells, but local transpiration may have resulted in actual shrinkage. The optimum temperature for this plant is also a feature not yet determined.

The growth of the opuntias therefore takes place during a period of decreasing acidity resulting from the disintegrating action of light and rising temperatures. This statement applies not only to the diurnal behavior of the plants during the growing season, but to the growing season as a whole, which as Dr. H. M. Richards has pointed out in a paper now in press is one of diminishing acidity. The acidities of the cacti are calculated for the sap of the plants. The acidities of N/100 to N/3,000 found by Borowikow to be favorable for hydratation and growth were of the culture solution; that of the sap of the seedling used was probably still much lower.

Light and temperature in lesser degree are seen to exercise a totalized releasing effect on growth coincident with reduced acidity and increased hydratation, to a certain limit. Beyond this growth rate is checked. Further analytical tests will be necessary to determine the limiting factors.

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PROCEEDINGS OF THE ANNUAL MEETING OF THE AMERICAN SOCIETY OF ZOOLOGISTS HELD IN PHILADELPHIA, 1914. II

Multiple Human Births: G. H. PARKER.

Multiple births are well known among human beings and the proportions of twins, triplets, and quadruplets to single births have often been recorded. Instances of five and six children at a birth are very rare but apparently well authenticated. All cases above six are very doubtful. In the *Boston Medical and Surgical Journal*, Volume 10, page 224, 1872, is recorded from Trumbull County, Ohio, a case of eight children at a birth. This very circumstantial account, which has been quoted in numerous books and journals, proves on investigation by the county clerk of Trumbull County to be entirely fictitious.

Comparative and General Physiology

Effect of Electrolytes Upon the Rate of Nerve Conduction in Cassiopea: ALFRED G. MAYER.

Further Studies on the Behavior of Amœba: ASA A. SCHAEFFER.

The Significance of Certain Internal Conditions of the Organism in Organic Evolution: F. H. PIKE AND E. B. SCOTT.

Zoologists, while studying the phenomena of form regulation in animals, have given comparatively little thought to the regulation of internal conditions—the changes in matter and energy in the organisms which underly the changes of form.

The data accumulated in the physiological laboratories show that in the higher animals there is a regulation, varying within relatively narrow limits, of body temperature, the blood pressure, the tension of carbon dioxide and oxygen, of the concentration of hydrogen and hydroxyl ions, of the osmotic pressure, and of the general composition, quantitative as well as qualitative, of the fluids of the body, brought about by a number of systems and organs of the body.

From the point of view of the physical chemist, the general constancy of internal conditions of the higher organism may be interpreted in terms of chemical equilibrium. If the reactions within the body are of the nature of the "slow" reactions of the chemical laboratory, the constant temperature and the constant physico-chemical concentration of the body fluids would be attended by a speed of reaction within the body which would be, in a considerable degree, independent of the conditions in the environment. The internal mechanisms of the organisms lie at the base of the diminishing effect of the environment, or the greater degree of independence of the animal from the conditions of the environment as the organisms occupy successively higher positions in the evolutionary scale.

Experiments on X-Radiation as the Cause of Permeability Changes: A. RICHARDS.

Some Factors Concerned in the Death of Paramœcium at High Temperatures: M. H. JACOBS.

The Effect of Color in the Environment on the Color Changes of Anolis Carolinensis: MANTON COPELAND.

It is well known that the so-called *Florida chameleon, Anolis carolinensis* Cuv., becomes green in the dark and almost invariably turns brown in daylight. To test the effect of color in the environment on the color changes in the skin of the lizard, the animals were placed in boxes lined in part with colored paper and exposed to daylight. It was found that the green color was often assumed under such conditions. A yellow environment always induced a change from brown to

green. Green surroundings were nearly as effective in bringing about this reaction, whereas red and blue were much less so. When placed in a white box certain individuals became green. The brown color was assumed when a box lined with black paper was substituted for a color box. The green hue persisted with slight change for several hours when the animal was in the yellow environment.

When a lizard was blindfolded it remained brown in the yellow box, and numerous tests showed conclusively that the organs concerned in receiving light stimuli, which induced a color change in the skin from brown to green, were the lateral eyes.

The Absorption of Fat by Fresh-water Mussels: E. P. Churchill. (Introduced by Caswell Grave.)

The work was undertaken for the U. S. Bureau of Fisheries with the object of ascertaining whether or not aquatic animals use food which is in solution in the water. Mussels were kept in soap solutions made from olive oil, both unstained and stained with Sudan III. Histological examination of such mussels and of controls revealed the fact that fat is absorbed abundantly and carried over the body by the blood corpuscles and plasma. Sections of mussels kept in fat solutions short periods, as 18 or 24 hours, showed such a heavy loading of fat in the epithelium of gills, mantle and foot that it seemed very probable that the cells of such epithelium absorbed the fat directly from the solution. Mussels with the valves wedged open were suspended over the solution, so that only the ventral part of the foot and mantle were immersed, the mouth and siphons being above the solutions. Examination after some hours of the parts of epithelium so exposed showed more fat than in the epithelium of other parts or in that of the corresponding regions of the control. Fat can be absorbed from solution by the epithelium of intestine and probably outer body walls.

Vision in Flounders: S. O. Mast.

Flounders, especially *Paralichthys* and *Ancylopsetta,* simulate the background to a most remarkable degree. The process of simulation involves changes in shade, in pattern and in color. Since all of these changes are controlled by stimuli received through the eyes, the nature and the degree of simulation of the background constitutes an excellent criterion of vision, in so far as this term may be used in a purely objective sense.

On the basis of this criterion it was found that, in regard to shade and color, vision in fishes is essentially the same as it is in human beings. It was also found that these animals distinguish between dots 2 mm. and 3 mm. in diameter respectively, that they recognize dots 1 mm. in diameter but that they do not recognize dots 0.5 mm. in diameter.

By means of a background consisting of a rotating disk which contained alternate black and white sectors, it was found that the fusion-rate of images in flounders corresponds very closely with that in the human being, indicating that in regard to motion vision in fishes is as acute as it is in man.

On a background containing only gray or black and white, no color is produced in flounders regardless of the shade or pattern or the intensity of the light. Simulation in color is consequently dependent upon the length of the waves of the light, not upon differences in its intensity. It therefore strongly supports the contention that fishes have color-vision. This is, moreover, supported by the fact that flounders adapted to a given color tend to select a background of the same color, and the fact that this selection is of such a nature that it can not be accounted for on the basis of difference in the intensity of the light reflected by the different colors. Thus the contention that fishes have color-vision is supported both by the reactions of the animals and by the reactions of the chromatophores in the skin.

Influence of Thyroid Ingredients on Division-rate in Paramœcium: R. A. Budington and Helen F. Harvey.

Paramœcia of known ancestry were placed in bacterial infusions of known composition. These were kept on hollow slides in moist chambers in the usual manner. To certain slides were added equal amounts of dried thyroid glands taken from types of each of the five main subdivisions of Vertebrata. Besides each thyroid-treated line was carried a control line, two progeny of a single dividing individual being used in the experiment.

The number of individuals resulting from fission in each line was counted each day; at the end of six days the following were the data secured, each figure being the average of three repetitions of the same experiment:

Fish thyroid	70.6
Control	36.6
Amphibian thyroid	111.3
Control	20.0
Reptilian thyroid	225.3
Control	24.3

Avian thyroid	222.0
Control	43.6
Mammalian thyroid	315.3
Control	57.3

The conclusion is that throughout the evolution of the vertebrate phylum, the thyroid has retained certain of its physiological characters intact. The observations previously made by Nowikoff, later by Shumway, on mammalian thyroid influence on *Paramœcium* are thus confirmed, and the significance of the facts extended so as to include the homologous glands of each of the other four classes of vertebrates.

The Effect of the Removal of the Marginal Sense Organs on the Rate of Regeneration in Cassiopea Xamacana: LEWIS R. CARY.

The results of the investigations of most workers on regeneration has shown that no direct effect of the nervous system upon regeneration could be demonstrated. Zeleny concluded as a result of his work on Cassiopea that when the sense organs were removed the animals regenerate sometimes faster and sometimes slower than do specimens with the sense organs intact. Stockard removed the sense organs from one half of a *Cassiopea* disk and insulated the two halves by removing a strip of sub-umbrella tissue so that one half was active, the other inactive, and found that the rate of regeneration was the same in both halves. From these experiments he concluded that muscular activity had no influence on the rate of regeneration.

In a large series of experiments on *Cassiopea* disks prepared in the manner just mentioned I have obtained the following results:

1. When entire disks are used for the experiments those from which the sense organs have been removed may regenerate slower or faster than those retaining their sense organs on account of individual variation in the rate of regeneration.

2. In specimens prepared so that one half is active, the other inactive, the active side (that bearing the sense organs) always regenerates fastest. The difference in rate is particularly noticeable in earlier stages of regeneration.

3. When the sense organs are removed from one half of the disk, but the halves not insulated, the rate of regeneration is the same for both sides. If only a single sense organ remains the results are the same.

4. In a solution made up of sea water to which has been added 15 volumes per cent. of 0.6 M $MgSO_4$ the regeneration is equal from both sides, but at the rate of the inactive half of a specimen from which one half the sense organs have been removed.

5. In specimens from which all sense organs have been removed but in which one half is kept in pulsation by means of a trapped wave of contraction, the regeneration is the same for both halves, although the rate of contraction in the active half may be higher than for a half disk on which the sense organs are present.

The rate of metabolism as determined for the writer by Dr. S. Tashiro is higher for the half disk bearing sense organs than for the inactive half, or for the half that is kept in contraction by means of a trapped wave.

The Locomotion of Actinians: G. H. PARKER.

The creeping habits of *Metridium* and *Sagartia* were studied at Woods Hole and of *Condalactis* and *Actinia* at Bermuda. *Metridium* and *Sagartia* creep slowly and in directions which may be in one individual at right angles to its axis of structure, in another coincident with it, and in still another oblique to it. Whether one individual could assume in sequence all these directions was not ascertained for these sea anemones. In *Condalactis* and *Actinia* the creeping was more actively carried out than in *Metridium* and *Sagartia.* A single *Actinia* crept now in the direction of its axis, now at right angles to it, and now in some other direction. There is no reason to suppose that this freedom is not possessed by the other sea anemones. In all the forms studied locomotion was accomplished by a wave-like movement of the foot. This began at the rear edge of the foot and proceeded to the front edge. It was exactly like the direct type of wave seen in the mollusk foot, but could be established temporarily on any axis. In *Condylactis* it required about three minutes for a wave to pass over the foot and with each wave the animal progressed a little over a centimeter in distance.

The Behavior of an Enteropneust: W. J. CROZIER.

A species of *Ptychodera* found in Bermuda was studied with reference to its movements and sensory reactions. The orderly progression of peristaltic waves on the thorax and abdomen was found to depend upon the continuity of the dorsal and ventral nerve cords. At night the animal responded to general mechanical stimulation by the emission of a phosphorescent material from the collar region. *Ptychodera* showed "differential sensitivity" to light; it was not photographic.

Local reactions were obtained in response to mechanical and chemical stimulation, the order of decreasing sensitivity of the parts of the animal being: proboscis, posterior end, genital pleuræ, the alkaline metals the normal lyotropic series, abdominal surface, collar. For the chlorides of $K > NH_4 > Li > Na$, was found to express their stimulating efficiency; this was mainly a kation stimulation, but in the case of salts ($CaCl_2$, *e. g.*,) which did not stimulate strongly, other anions (in this case $Ca(NO_3)_2$) were effective as stimulating agents. Photic sensitivity was readily separated, by exhaustion or anæsthetics, from mechanical and chemical; but for the two latter forms of irritability no physiological separation was discoverable. It is therefore suggested that in *Ptychodera* there are generalized receptors open to stimulation by both mechanical and chemical means.

On a Certain Fibrin Reaction Which Occurs in Living Cultures of Frog Tissues: GEORGE A. BAITSELL.

In living cultures of various tissues of the adult frog there occurs, in many instances, a transformation of the fibrin net of the plasma clot in which the living tissue is embedded. In general the changes which occur first make their appearance when the culture is from two to three days old. During these changes the elements of the fibrin net appear to fuse or consolidate and as a result there are formed a great number of fine wavy fibrils which unite to form bundles of fibers, and these freely intertwine and anastomose as they ramify throughout the area of the plasma clot. The transformation of the fibrin net begins first in the region of the clot which lies in immediate contact with the embedded tissue and gradually extends to the distal regions of the clot until after a time practically the entire plasma clot becomes changed into a tissue greatly resembling that found in various types of connective tissues. Photographs of both living and preserved cultures have been made to show the transformation of the clot and the development of the fibers. Experimental work shows definitely that the fibers arise by a transformation of the fibrin net and are not due to any intracellular action. The work also indicates that the transformation will not take place without the influence of living tissues, although mechanical factors may be introduced which will aid in the formation of the fibers. Various experiments made to determine the true nature of the fibers give conflicting results. The fact, however, that the fibers have also been found to occur in the fibrin net during wound healing indicates that they play an important part in such a process. Studied histologically with a Mallory stain, there appears to be nothing to differentiate them from regular connective tissue fibers. Work is in progress to determine their final fate and the relation they bear to permanent connective tissue fibers.

Studies on the Phosphorescent Substance of the Fire-fly: E. NEWTON HARVEY.

Dried powdered luminous tissue of the fire-fly will phosphoresce strongly if moistened with water containing oxygen. If first extracted with boiling ether or a mixture of equal parts boiling ether and alcohol for eight hours and the solvent then removed, strong phosphorescence still occurs when water containing oxygen is added to the dry powder residue. Similar results are obtained with hot chloroform and acetone, and cold carbon tetrachloride and toluol.

If oxygen-free water is added to the dry powdered luminous tissue no phosphorescence occurs. If oxygen is then added light is emitted. But if no oxygen be admitted until an hour or more after contact of the powder with oxygen-free water, then phosphorescence does *not* occur. Salt, acid and alkaline solutions give similar results.

From these experiments we may conclude: (1) that the photogenic material is not a fat or a lecithin; (2) that the photogen or some accessory substance is unstable and decomposes in the presence of aqueous solvents even though oxygen be absent. The change is therefore not oxidative in nature. It is well known that the photogen oxidizes readily in presence of oxygen and is used up with light production.

Dried luminous bacteria give similar results, with this exception, that extraction with chloroform, acetone and a mixture of equal parts boiling alcohol and ether destroys or weakens the powder to phosphorescence. The bacterial photogen is also unstable if the bacterial cell is broken up in the absence of oxygen.

Some Experiments on Fundulus Eggs Aiming at the Control of Monstrous Development: E. J. WERBER.

Starting from the assumption that human and other mammalian monsters found in nature may be due to a pre-uterine or intra-uterine poisoning by the substances found in the blood under pathological conditions of metabolism, such as diabetes, nephritis, jaundice, etc., eggs of *Fundulus hetero-*

clitus were subjected to the action of solutions of urea, butyric acid, lactic acid, sodium glycocholate and ammonium hydroxide. Conclusive results were obtained only with butyric acid and acetone.

The effects of both these substances are very similar. If *Fundulus* eggs are subjected to their influence, they will give rise to a great variety of monsters. Cyclopia, asymmetric monophthalmia and neuroplastic development (microembryones, hemiembryones anteriores) were found to occur most frequently. Not uncommonly is the occurrence of acardia in malformed embryos. In some eggs a heart and rudimentary blood-vessels have developed without the presence of an embryo.

The ear vesicles are very often involved in malformations, their size being enormous, owing apparently to edema. Some locomotor anomalies in embryos, which had hatched, pointed to injury sustained by the semicircular canals.

The rarest in occurrence, but probably the most significant from the standpoint of experimental embryology, were found some cases where all that had developed in the egg was a fragment of brain tissue which had given rise to an eye. This "solitary" eye was found to be almost perfect in some cases, while in others the choroid fissure had failed to close ("coloboma"). Sections of one of these eggs show an eye typical in structure. This would seem to establish the fact of the ability of independent development of the eye.

Reactions to Light in Vanessa lantiopa, with Special Reference to Circus Movements: WM. L. DOLLEY, JR. (Introduced by S. O. Mast.)

The Reactions of the Melanophores of Amblystoma Larvæ: HENRY LAURENS.

A Case of the Change of Fat, in Nature, to Calcium Soap: R. W. H. WOLCOTT.

The Balance Between the Hydrochloric Acid of the Stomach and the Sodium Carbonate of the Pancreas in Its Relation to the Absorption and Utilization of Sugar: J. R. MURLIN.

The Electric Nerve Centers in the Skates: ULRIC DAHLGREN. (With lantern.)

Food Reactions of the Proboscis of Planaria: WM. A. KEPNER AND ARNOLD RICH.

The removal of part of the proboscis sheath results in exploratory movements of the proboscis. As the sheath is further removed these exploratory movements become more pronounced. Such movements, however, are not maintained for more than two minutes.

Sectioning the living animal posterior to the base of the proboscis does not disturb in any other manner the proboscis. By removing anterior parts of the body little disturbance of the proboscis results until the plane of sectioning gets quite near the base of the proboscis, when the latter undergoes either mechanical or autoamputation and leaves the proboscis sheath and for at least ten minutes swims about as an independent organism, ingesting food in a futile manner. The proboscis thus freed frequently turns upon its own body and by ingesting it reduces the body to mere pulp.

It is concluded, therefore, that there is resident in the proboscis an instinct to ingest objects. The inhibitory control of this instinct does not lie in the dorsal ganglia, but in a region of the body anterior to and quite near the base of the proboscis.

Preliminary Report on the Relations Between the Reactions of Rhabdocœles and Their Environments: WM. A. KEPNER AND W. H. TALIAFERRO.

In a previous paper[2] the authors showed that *Microstoma caudatum* when kept under laboratory conditions shows two physiological conditions. In the first place if they are experimented on a few hours after collection they will distinguish between their aquarium water and 5/100 per cent. ordinary salt solution. However, if they are experimented on over a day after collection they do not make this distinction, thus showing that their physiological condition has been lowered. We, likewise, showed that this lowering of physiological condition is due to the rapid accumulation of bacteria under laboratory conditions.

While experimenting on a number of other species of *Rhabdocœles* we found that some showed this loss of physiological condition just as *Microstoma*, while others showed no lowering of their physiological condition, no matter how long they lived under laboratory conditions.

To find an explanation of these results, which at first seemed contradictory, we investigated the natural habitat of the various animals. Here we found that those animals which showed a lowering of physiological condition lived rather deep under the surface of the pond, on roots, where there were relatively few bacteria. On the other hand those that did not show this lowering of condition lived near the surface, in the presence of a great amount of decaying vegetable matter, and hence a great number of bacteria.

[2] "Sensory Epithelium of Pharynx and Ciliated Pits of *Microstoma Caudatum*," *Biol. Bull.*, Vol. XXIII., No. 1, 1912.

From these experiments we conclude that those animals that live in the presence of a great number of bacteria can withstand the action of these bacteria, while those that do not, can not withstand this action, or that the natural habitat of the animal is the real conditioning factor in its reactions.

The Rhythmic Pulsation of the Cloaca of Holothurians: W. J. Crozier.

The cloacal region of pedate holothurians contains within itself the mechanism of its coordinated pulsation. The isolated cloacal end pulsates rhythmically for many hours after its separation from the rest of the animal, and forms a very simple prepared object with which to investigate phenomena of rhythmic movement. The rate of pulsation of the isolated cloacal extremity of *Stichopus mœbii* was found to have a temperature coefficient of about 2.4; it was capable of long continuance in water practically free from dissolved oxygen. The coordinating mechanism was much more powerfully affected by nicotine and atropine than by cocaine or morphine. The duration of pulsation and of irritability to mechanical stimulation in diluted sea water was proportional to about the square of the concentration. The alkaline chlorides preserved pulsation and irritability in the order:

$$NaCl > LiCl > NH_4CK > KCl \cdot MgSO_4$$

was a more powerful depressant than isomolecular or (Mg-) isionic $MgCl_2$. Each one of the salts of sea water was necessary for the continuance of pulsation; this was notably true of $MgSO_4$, which led to normal relaxation after systole. Alteration of the C_H. from $p_H = 8.0$ (normal) to $p_H = 6.0$ was sufficient to produce stoppage of pulsation within 5 minutes. The brownish skin pigment was given out under abnormal ionic or osmotic conditions, and afforded some index of permeability changes.

Ecology

Altitudinal Distribution of Plankton Crustacea in Colorado: G. S. Dodds.

In 284 collections from 124 lakes and ponds, at elevations between 4,100 and 12,188 feet, the author found 50 species of Entomostraca. Other records raise the list to 69 species (Phyllopoda 14, Cladocera 35, Copepoda 20). There are 22 species confined to the mountains, 27 found only in the plains, and 20 range more or less widely through both areas. More definitely, there may be recognized four zones, marked more or less clearly by physiographic, climatic and faunal characters, as follows: Plains Zone, up to 5,400 feet; Foothill Zone, 5,400 to 8,500 feet; Montane Zone, 8,500 to 11,000 feet; Alpine Zone, above 11,000 feet. In determining distribution of species and boundaries of zones, temperature seems to be the most important factor.

In climate and fauna, these zones have their nearest geographical equivalents as follows: Alpine zone to Labrador, southern Greenland and extreme north of Russia; Montane and Foothill zones to the region north of Lake Superior, Newfoundland, and the main part of Norway and Sweden. The plains zone to the Mississippi valley and the lowlands of Europe, except that the semi-arid climate gives some specialized features.

The Land and Fresh-water Crustacea of Colombia: A. S. Pearse. (Lantern slides.)

The Vertical Distribution of Some Plankton Protozoa in Wisconsin Lakes: Chancey Juday.

An Experimental Transmission of Sarcocystis Tenella: John W. Scott.

Exceptional Life-histories Among the Unionidæ: Arthur D. Howard.

Glochidia of a fresh-water mussel (Unionidæ) were found upon the external gills of *Necturus maculosus.* Eighty per cent. of the collections from the Mississippi were infected. By keeping the necturus alive from October to May the larval mussels were carried through the metamorphosis. The species was still unknown, as it did not correspond with any of the collection of glochidia available and which was supposed to be complete for the region. Study of the ranges of all reported forms revealed one rare species, *Hemilastena ambigua* Say, which might be the adult desired. Gravid mussels containing glochidia were found after considerable search late in September and a comparison with the glochidia in question removed all doubt that they were of the same species. The mussel has the unusual habit of living under flat stones of the flag-stone type. As *Necturus* is known to frequently seek such shelter, the manner of infection is explained.

Anodonta imbecillis has been reported by Sterki as normally hermaphroditic and by Howard as non-parasitic. The embryos have been observed within the egg-membrane up to the attainment of the juvenile stage. They were found to escape from the parental marsupium in late spring and their development followed to a growth of shell many times that of the original glochidium. Observations of the degree of development at various

seasons show a lack of agreement with conditions to be seen in most bradytictic or long period breeders. The following counts illustrate this:

Locality	Date	Eggs				Total
		Early Embryo	Late Embryo	Glochidia	Juveniles	
Moline, Ill.	November 7, 1913	7	3	7	5	22
Fairport, Ia.	May 1, 1914	2	1	5	6	14

Glochidia of *Strophitus edentulus* escaping at various times during the spring from the parent mussel were tested for reactions to sodium chloride, the blood of fishes and contact of fins. A closing reaction was seen in each case. This led to an attempt at normal infection with entire success. The juvenile stage was obtained after a parasitic period of 27 days on the black bass. We have failed, after studies covering two years, to observe development without parasitism in this species. It would seem, therefore, that non-parasitic development as reported for this species is exceptional.

The Isolation of the Okefinokee Swamp Islands, a Segregative or Convergent Factor in Species Formation: ALBERT H. WRIGHT.

The Reaction of Herring and Other Salt-water Fishes to Decomposition Products Normal to Sea-water: V. E. SHELFORD. (With lantern.)

Herring are very sensitive to hydrogen sulfide and carbon dioxide, dying very quickly in small quantities of the former and more quickly than fresh-water species in fatal concentrations of the latter. They turn back upon encountering hydrogen sulfide in sea water and react to hydrogen ions, selecting essential neutrality with a precision showing sensitiveness equal to litmus. When differences in acidity are present they do not react to differences in salinity and density. They react to differences in temperature as small as 0.2° C.

Some Results of the Indiana Lake Survey: WILL SCOTT.

Some Phenomena of Parasitism with Especial Reference to the Unionidæ: ARTHUR D. HOWARD.

The usual type of parasitism among the Unionidæ is little more than commensalism, apparently. The young mussel or glochidium is embedded in the epidermis of the host, where in the process of metamorphosis little besides protection and transportation are afforded. In addition to this common and intermediate condition we meet with two extremes; on the one hand, a pronounced dependence upon the host in which considerable growth of the parasite takes place as in the Proptera group. On the other, a complete loss of parasitism with independence of a host in which the glochidium remains in the maternal marsupium until the adult form is reached, as in *Anodonta imbecillis.* The existence of these extremes with intermediate gradations presents quite a range of conditions. The observation of loss of parasitism in *Anodonta imbecillis* brought up the question as to how far the normal appearing glochidia had lost the function for which their structure adapted them. Fresh-cut fins with the blood from live fishes were presented. The snapping reaction was obtained. Infection on fishes was tried without success until glochidia from a number of individuals were used. Infection with complete encystment was then secured. They were not carried beyond this stage.

The recognition of restricted parasitism among the Unionidæ has led to the discovery of some interesting ecological relationships, such as *Anodonta pustulosa* to the catfishes, *Quadrula ebenus,* to the herring; *Lampsilis anodontoides* to the grapikes, the Proptera group and the Plagiolas to the sheepshead.

The relationship between *Hemilastena ambigua* and *Necturus* is about the only case of which we have anything like a complete knowledge. The others mentioned are only a few of those known from hundreds of species of mussels the hosts of which are not known.

The elimination by fish of inappropriate mussel parasites is a phenomenon which we have often observed. The process seems to be one of catarrhal shedding of the external epithelial cells of the fish's gills. Such mechanisms of immunity raise the question as to the perhaps more wonderful adaptations seen in the persistence of the parasitic glochidium when it finds the appropriate host species.

Miscellaneous

Problems of Antarctic Bird Life: R. G. MURPHY.

Some Experiments on Protective Coloration: R. G. YOUNG.

The various theories of protective coloration are based on the assumption of the usefulness of such color. This has frequently been questioned, and lacks as yet adequate experimental support. In order to test the usefulness of color in protecting

animals from their enemies, a series of about 140 experiments, covering a period of six years, has been carried out with various species of caged, and in a few cases with wild birds, to which were fed several kinds of small mammals and insects. The latter were placed upon different backgrounds, with some of which they formed strong contrasts, while others they closely resembled. The birds were then allowed to choose between that prey which resembled, and that which contrasted with its background.

The experiments may be divided into two classes—those in which the birds usually approached their prey swiftly from a short distance, and those in which they approached it slowly, and seized it only after careful inspection. In the former class over 90 per cent. of the combinations chosen were contrasting, while in the latter, the contrasting combinations were chosen but little oftener than the non-contrasting ones.

The experiments indicate that the color of a motionless animal has a decided survival value when it is attacked by birds which approach it swiftly from a distance of even a few feet.

Immunity of Fowls to Cysticerci of Certain Cestodes: J. E. Ackert

Regeneration of Head Parts in Earthworms After Removal of the Anterior Portion of the Digestive Tube: H. R. Hunt. (Introduced by Herbert W. Rand.)

The object of these experiments was to determine whether the brain and commissures could be regenerated and the stomodeum formed in regenerating earthworms in the absence of the anterior end of the digestive tube. The first three anterior segments of the worms were removed and the digestive tube carefully removed from the first five or six segments posterior to the point where the head was cut off. One hundred and seventy-seven individuals of *Eisenia fœtida* and thirty-two individuals of *Helodrilas calliginosus* were used. Seventy-eight worms survived. In six specimens head parts regenerated when the anterior end of the digestive tube was three to five segment lengths from the anterior end of the worm. The six worms fall into three classes: in the first class a stomodeum was formed; in the second class a brain fundament and commissures were regenerated; in the third class a brain fundament and commissures regenerated and a stomodeum was formed.

I am indebted to Professor H. W. Rand, of Harvard University, for many helpful suggestions.

An Interesting Snail from Minnesota and a Problem in Geographical Distribution: R. W. H. Wolcott.

Exhibits

During the meeting the following exhibits were made in one of the rooms of the Zoological Laboratory of the University of Pennsylvania:

Exhibits and Demonstrations

Franklin D. Barker: The Absence of Male Reproductive Organs in Trematodes.

J. W. Mavor: The Larval and Post-larval Development of the Coral, *Agaricia Fragilis,* Dana.

Chester H. Heuser: Drawings and Models of the Stomachs of Embryo Cat, Albino Rat, Pig and Sheep.

E. J. Werber: Demonstrations of Some Sectioned and Unsectioned Material of Monstrous Embryos of Fundulus.

Harold S. Colton: Methods Used in Producing Changes Within Pure Lines of the Pond Snail, *Lymnæa.* (Room 104, Zoological Laboratory.)

T. H. Morgan, A. H. Sturtevant, C. B. Bridges and H. Muller: Demonstration of the Four Hereditary Groups and the Four Pairs of Chromosomes of *Drosophila.*

S. O. Mast: Autochromes from Life Showing Adaptation in Color in Flounders.

Caswell Grave,
Secretary-treasurer, American Society of Zoologists

SOCIETIES AND ACADEMIES

THE AMERICAN MATHEMATICAL SOCIETY

The one hundred and seventy-fifth regular meeting of the society was held at Columbia University on Saturday, February 27, 1915, with an attendance of 39 members at the two sessions. President E. W. Brown occupied the chair, being relieved by Vice-president Oswald Veblen at the afternoon session. The following persons were elected to membership: Professor J. V. Balch, Bethany College; Professor E. J. Berg, Union College; Mr. Millar Brainard, Chicago, Ill.; Mr. L. C. Cox, Purdue University; Mr. C. H. Forsyth, University of Michigan; Dr. H. C. Gossard, University of Oklahoma; Mr. M. S. Knebelman, Lehigh University; Dr. W. V. Lovitt, Purdue University; Dr. L. C. Mathewson, Dartmouth College; Mr. A. L. Miller, University of Michigan; Dr. Bessie I. Miller, Johns Hopkins University; Mr. I. R. Pounder, University of Toronto; Mr. L. L. Steimley, Indiana University; Mr. Chid-Cheow

Yen, Tangshan Engineering College. Three applications for membership were received.

The following papers were read at this meeting:

M. Fréchet: "Sur les fonctionnelles bilinéaires."

A. S. Hathaway: "Gamma coefficients."

P. H. Linehan: "Equilong invariants of irregular and regular analytic curves."

B. H. Camp: "Multiple integrals over infinite fields."

A. R. Schweitzer: "On the methods of mathematical discovery."

P. R. Rider: "An extension of Bliss's form of the problem of the calculus of variations, with applications to the generalization of angle."

E. B. Wilson: "The Ziwet-Field note on plane kinematics."

O. E. Glenn: "Ternary transvectant systems."

E. J. Miles: "Note on the application of the calculus of variations to a problem in mechanics."

A. B. Frizell: "The permutations of the natural numbers can not be well ordered."

C. H. Forsyth: "Osculatory interpolation formulas."

J. F. Ritt: "A function of a real variable with any desired derivatives at a point."

J. F. Ritt: "On Babbage's functional equation."

The next meetings of the society will be in Chicago, April 2–3, and New York, April 24. The summer meeting will be held at the University of California and Stanford University, August 3–5.

F. N. COLE,
Secretary

THE BIOLOGICAL SOCIETY OF WASHINGTON

THE 533d meeting of the Biological Society of Washington was held in the Assembly Hall of the Cosmos Club, Saturday, January 9, 1915. It was called to order by President Bartsch at 8 P.M. About 40 members were present.

The minutes of the 531st meeting were read and approved.

Waldo Schmitt, of the U. S. National Museum, was elected to active membership.

Under the heading Brief Notes and Exhibition of Specimens, Dr. L. O. Howard made remarks on the meetings held at Philadelphia during convocation week and Dr. Pilsbry discussed certain aspects of the Hawaiian land-shell problem. The latter said early collecting was done in the valleys, but recent work showed chief home of species to be on ridges. Distribution of forms occurred in groups and there were many instances of Mendelian inheritance between different forms carried out on large natural scale.

The first paper on the regular program was by Wm. Palmer: "An Unknown Fossil." Mr. Palmer exhibited the specimen from the Calvert Cliffs of Chesapeake Bay and hoped members would express views as to its nature. His own view was that it might represent the lower jaw of an unknown turtle. From the same locality other fossils were shown that had previously proved very difficult to identify. Mr. Palmer's communication was discussed by Professor Hay.

The second paper was by Professor Hay: "An Albino Terrapin." The unique specimen was exhibited; it was hatched near Beaufort, N. C.; an attempt was made to raise it, but it lived only a few months. Professor Hay took occasion to show excellent lantern slides of certain interesting crustaceans, especially of *Limnoria lignorum*, wood-boring Isopod, and of *Xylotria*, a wood-boring mollusk. Professor Hay's communication was discussed by Messrs. Bartsch, Wilcox, Palmer, Smith, Hopkins and by Miss Rathbun.

The last communication was by M. W. Lyon, Jr.: "Notes on the Physiology of Bats." The speaker stated little was known of exact physiology of bats, but discussed subject from broad standpoint of their physiology of locomotion, of food, adaptation and of special senses. Need of careful experiments on use of, and modern histological work on structure of nose leaves was pointed out. Paper was discussed by Messrs. Howard, Bishop, Hunter, Palmer and Stiles; Mr. Bishop giving an account of a bat roost near San Antonio, Texas, erected with the idea that bats would consume large numbers of malarial mosquitoes. Mr. Hunter stating that an examination of stomach contents of bats showed food of *Nytinomus mexicanus* consisted of 95 per cent. moths, the rest being carabid beetles, hymenopterous insects and a few crane flies, the only Diptera found, no mosquitoes being observed.

ON Tuesday, January 19, 1915, at 8:30 P.M., the Biological Society held a joint meeting with the Washington Academy of Sciences in the auditorium of the National Museum. Dr. Johan Hjort, Director of Fisheries of Norway, delivered an illustrated lecture on "Migrations and Fluctuations of the Marine Animals of Western Europe." About 200 persons were present.

The 534th meeting of the society was held in the Assembly Hall of the Cosmos Club, Saturday, January 23, 1915, with President Bartsch in the chair and 75 persons present.

Mr. R. A. Ward was elected to active membership.

Under heading Brief Notes, etc., Dr. Johan Hjort, Director of Fisheries of Norway, called attention to the large numbers of herring caught in Norwegian waters during the last few years, most of them belonging to what he termed the "1904 Class." Dr. Hjort attributed the great success of the "1904 Class" to the known lateness of season when it had been spawned and when the plankton was abundant. Early in spring the sea is practically barren of plankton and fish hatching at that time have little food.

The regular program was an illustrated paper by Mrs. Agnes Chase on "Developing Instincts of a Young Squirrel." Mrs. Chase had made careful observations and notes on the bringing up of a young gray squirrel during the past spring and summer. The animal was very young when first acquired by the speaker, needing to be fed on milk with a medicine dropper. Mrs. Chase described its growth, acquisition of squirrel-like habits and instincts. It was not brought up as a pet, but was given every freedom to develop its natural traits. At maturity it met with wild members of its own species, at first returned home, but finally remained away. Mrs. Chase had a few records of the squirrel after it had left; at one time it was seen in company with seven wild squirrels in a strawberry patch where it had once learned to feed. Wild squirrels had not been seen in this patch before and the speaker concluded they had been taught to eat strawberries and shown the place by her former pet.

The rest of the evening was given over to an exhibition of lantern slides on biological subjects. W. W. Cooke showed views of bird life; Dr. Smith, of Japanese silk industry; Wm. Palmer, of seals and birds of Pribilof Islands; Dr. Bartsch, of local birds.

M. W. Lyon, Jr.,
Recording Secretary

THE NEW ORLEANS ACADEMY OF SCIENCES

The regular monthly meeting of the New Orleans Academy of Sciences was held at Tulane University on Tuesday, January 19. In the absence of the President, Dr. Irving Hardesty presided. Two papers were presented at the meeting, the first by Dr. W. O. Scroggs, of the history department of Louisiana State University, on "The Mosquito Kingdom and Henry L. Kinney." According to Dr. Scroggs:

Early in the nineteenth century agents of Great Britain on the Mosquito coast, in eastern Nicaragua, persuaded the native chiefs in this region to recognize one of their number as king, and this half-breed sovereign was persuaded in turn to place his realms under the protection of the British Crown. In the United States it was feared that the British claims thus set up would prove an obstacle to the construction of the interoceanic canal. The Mosquito king meanwhile had made vast grants of his land to enterprising traders along the coast, and these concessions were bought up by an American adventurer, Henry L. Kinney, who undertook in 1855 to colonize the Mosquito coast with Americans and counteract British influences. Kinney's plans were laid on an elaborate scale, but he encountered such opposition from a syndicate of American capitalists at home and from a rival adventurer in Nicaragua, William Walker, that the enterprise failed, and he was financially ruined.

The second paper was by Dr. Gustav Mann, professor of physiology, Tulane University: "What part does water play in our economy?"

Dr. Mann discussed water metabolism. After a general survey of the total quantity of water in individuals of different ages and of that for individual tissues the absorption of water by the intestines, its storage especially in the muscles and its formation inside the body as a result of oxidation of fats, sugars and proteins was gone into. Then the advantages of the circulation of water within the body, the elimination by the salivary glands, the stomach and the intestines and re-absorption of water along with dissolved food substances was pointed out. The work done by Hawk along with Mattill and Hattrem was criticized. There can not be any doubt that an absorption of 4 to 5 liters of water per day greatly helps the digestion of carbohydrates, fats and proteins. It is necessary, however, to constantly bear in mind the amount of salt which is taken with the food. The effect which an excess of salt produces is to render the globulins of the body more soluble while large quantities of water produce the opposite effect. The great advantage of giving nutritive solutions hypodermically and thereby insuring a slow absorption of food radicals in contradistinction to giving salt solutions intravenously for purposes of raising blood pressure was explained. When talking about the elimination of water by the skin, lungs and kidney, the advantage of breathing through the nose and thus keeping the air passages moist to allow foreign material to be caught in the nasal passages was emphasized.

Both papers were the subject of considerable discussion. At the conclusion of the papers, Dr. Mann made an exhibit of brain and thalamus dissections made permanent by infiltration with solid paraffin.

R. S. Cocks,
Secretary

SCIENCE

FRIDAY, APRIL 2, 1915

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

MYCOLOGY IN RELATION TO PHYTOPATHOLOGY[1]

IN preparing a presidential address one has always to meet and answer the same old question that has confronted presidents and retiring presidents of societies ever since presidents and presidential addresses were invented, *i. e.*, Should the effort be primarily to entertain and amuse, or to instruct? I fear that any effort of mine to entertain would be a grievous failure, while an effort to instruct may be but little more successful. Since of two evils we are advised to choose the lesser, I have decided to attempt something more in the line of instruction than entertainment. Instruction is usually regarded, I believe, as a more or less normal function of a specialist, and as modern social and economic conditions have compelled specialization, we must accept the consequence.

The subject of plant pathology properly includes all the phenomena connected with abnormal forms and functions of plants. These abnormal conditions may be grouped in three classes, according to their origin: First, those which are of non-parasitic origin; second, those which are caused by plant parasites; third, those which are caused by animals. Excluding from present consideration diseases directly due to animals, we have left the two classes, non-parasitic and parasitic. By far the greater part of the trouble with which the phytopathologist has to deal are caused by plant parasites. In fact, the greater part of the phytopathology of to-day might quite properly be designated parasitology, and

[1] Address of the retiring president of the Botanical Society of Washington, March 2, 1915.

parasitology is of course only a branch of mycology.

Plant pathology is a subject of very recent development and can scarcely be said to have existed before the middle of the last century. During the period from 1830 to 1850 attention began to be given to this subject. Unger, Wiegmann, Meyen, Raspail and Regel wrote on the diseases of plants. These authors took up the subject from the standpoint of general botany and human pathology rather than mycology. Some very curious ideas prevailed; *e. g.*, it was believed that fungi such as rusts were produced by the puncture of insects (Raspail, 1846). Unger's idea was that certain fungi were outgrowths or modifications of the tissues of the diseased plant. These and earlier works contained various more or less academic discussions of various diseases, based largely upon erroneous ideas of the structure and nature of the parasite as well as the host. As an illustration of how persistent medieval ideas and conceptions are I may cite a recent instance. A correspondent, in explaining the cause of a strawberry disease, states that it is due to "elemental debasement." This reminds one of the "original sin" of the old theology, to which it may perhaps be closely akin.

Under the influence of the important contributions to the knowledge of the cellular structure and tissues of plants, which were made during this period, together with the work of contemporary mycologists, the foundation was laid for a more rational and correct interpretation of plant diseases and parasites.

Since the great majority of plant diseases are caused by fungi, it is quite proper that mycology should be considered the chief cornerstone of this branch of science and should be thoroughly understood by the plant pathologist.

In order to get a proper conception of any subject and to understand and appreciate its present condition and needs, a knowledge of its past history and development is necessary. It is quite appropriate that Florence, the chief seat of learning and the leader in literature, religion, art and science during the Renaissance and beginning of the modern era, with the illustrious names of Dante, Savonarola, Raphael and Michael Angelo should have produced the great botanist, Micheli, who may be justly considered the father of mycology. His great work, "Nova Plantarum Genera," published in 1729, was devoted largely to the description and illustration of fungi. This work remained unsurpassed for fifty years and is still recognized as a classic on this subject. Micheli's collections of fungi are still preserved in Florence beside those of Cesalpini. Some of his specimens compare favorably with those of much more recent mycologists.

Following Micheli some twenty-five years later came Battara, also an Italian. During the latter half of the eighteenth century Tode, Hoffman, Batsch, Bulliard and Persoon made important contributions to descriptive mycology. In the early part of the nineteenth century the most distinguished students of the subject were Persoon, Greville, Wallroth, Link, Sowerby, Fries and Corda in Europe, while in America the illustrious Schweinitz laid the foundations of American mycology and took rank among the first mycologists of the world. Following him in this country came Curtis, Ravenel, Peck, Ellis, Farlow and Burrill. Most of the work of the early writers was systematic, and may appear to some of us to be very crude and unsatisfactory, but when we consider the conditions under which they labored and the tools and technique available, it will be found that their work is of as high quality

as could be expected; and is perhaps no more imperfect than ours will appear to mycologists and pathologists a century hence.

Beginning about 1850, there was a great change and improvement in methods and aims in mycological work. The two most conspicuous men of this period were De Bary and Tulasne, who understood a careful comparative study of all that was known of the morphology and physiology of fungi, as well as original investigations of the life histories of the organisms. At the same time Berkeley in England, while devoting his time chiefly to descriptive work, gave much attention to the pathological aspects of the subject and published a very important series of papers in the *Gardener's Chronicle* (1854) on "Vegetable Pathology." In this connection, M. C. Cooke, who has recently passed away, should be mentioned. In America Farlow, Bessey and Burrill first introduced laboratory methods of studying fungi, taking up the work along the lines indicated by De Bary and Tulasne.

NOMENCLATURE

In considering the various phases of mycology in their relation to plant pathology, the subject of nomenclature deserves mention. The plant pathologist as well as the mycologist must use plant names. It is therefore important that this matter should be given careful consideration, in order to devise means of securing as nearly as possible uniformity and stability of usage. Unfortunately at present there is no generally accepted method of accomplishing these ends. It is therefore desirable that pathologists take an active interest in this subject and assist in determining what the fundamental requirements are to secure uniformity and stability and exercise their influence to secure the general adoption of such regulations. One of the subjects of most fundamental importance in this connection is that of types. It does not seem possible to secure any great degree of uniformity in the use of names until generic and specific names are fixed to definite types. Teachers of mycology and pathologists should consider these matters in a scientific spirit and without reference to personal preference or professional affiliations.

Closely related to this subject is that of terminology in general. There is at present a decided lack of accuracy and uniformity in the use of the various technical terms used in mycology and pathology. With the exception of the rusts, the descriptive terms used have not been accurately defined and coordinated in accordance with our present knowledge; *e. g.*, the term conidium is variously applied to spores produced either on external sporophores or within pycnidia. There is also lack of general agreement and uniformity in regard to the names applied to the various conidial and pycnidial forms of the Ascomycetes. We have such terms as stylospore, spermatium, micro- and macro-pycnospore, micro- and macro-conidium variously applied by different writers.

Of great importance also to the pathologist is the standardizing of methods and technique as far as possible. Though absolute standards in these matters can not well be attained, effort should be made to approximate definite standards as closely as possible.

TAXONOMY

Mycology formerly consisted chiefly of the identification of old species and the describing of so-called new species. This of course was natural and necessary, as there was a vast unknown group of organisms most of which had not been named or described. Unfortunately, the overwhelm-

ing number of the species and the few workers made it impossible for them to devote the time and study to the organisms necessary for satisfactory segregation and description. Species were usually based upon supposed host relations, slight morphological differences or geographical distribution. More recent and thorough studies have shown that these can not be generally depended upon. While one species of a genus may have very definite host relations, the next one may be very indefinite in this respect. In the same way morphological characters which are reliable in one genus or species may be very variable and unreliable in another. The same may be said of geographical distribution. Some species are apparently more or less cosmopolitan, while others are confined to rather limited geographical areas. These facts can only be determined by the most thorough monographic study of each genus or group. Our studies of *Endothia* have brought out these points with great clearness and emphasis. For instance, one of our American species, *E. gyrosa,* extends from the Atlantic coast to the Pacific, and from Connecticut and Michigan to Florida and Texas, whereas its near relative, *E. radicalis,* is restricted to the Appalachian region in America. Such facts are of exceeding importance to the pathologist in determining the nature and possibilities of a parasite.

LIFE HISTORIES

Of still greater importance to pathology, however, is a knowledge of the life histories of parasites. This subject is not only of exceeding importance to pathology, but also to phylogeny and taxonomy in general, and has important bearings on all other branches of mycology. The work of Tulasne and De Bary and their contemporaries was the first important contribution to this subject. Following the discovery of the pleomorphy of the Ascomycetes there was a tendency on the part of some mycologists to connect up all the various known forms of the so-called Fungi Imperfecti upon the basis of association, similarity or other more or less uncertain evidence. One of the most striking cases of this is furnished by Fuckel in his "Symbolæ Mycologicæ," 1869, where supposed pycnidial or conidial forms are given for the majority of the Ascomycetes listed. In some cases the author was probably correct, but none can be accepted without being verified by cultural studies or other reliable methods. The work of Tulasne, while much more reliable and satisfactory, was based primarily upon the intimate association or union in the same stroma of the different forms of fructification. Much of his work has already been verified by later investigators. Brefeld in his great work on the life histories of the fungi made an exceedingly important contribution to this subject. Unfortunately, many of the conidial and pycnidial forms which he obtained in culture from ascospores can not be identified and connected with certainty with forms already described.

It has already been thoroughly demonstrated that some of the Pyrenomycetes have from one to three metagenetic spore forms besides ascospores; *e. g., Sphærella, Glomerella, Guignardia, Plowrightia,* etc. It is also well known that some of the stages of a fungus may be parasitic and others apparently saprophytic; *e. g.,* many Pyrenomycetes mature their perithecia upon dead vegetable matter, while their pycnidial or conidial forms may be actively parasitic. This has led to the classification of most of the Pyrenomycetes, whose life histories are not known, as saprophytes. It is clear, therefore, that to even be able to classify an organism satisfactorily as a

parasite or saprophyte its life history must be known.

Here is a vast field for investigation which offers great opportunities for making valuable contributions to knowledge. Thousands of pleomorphic species whose life histories are unknown await the patient and properly equipped investigator. Present culture methods must be improved and new methods probably devised in order to induce many of these fungi to pass through their complete life cycles. It is in this field that we may expect very important discoveries in regard to the factors which determine the production of any particular spore form in the life cycle of a fungus. Of such factors we have very little definite knowledge at present.

PARASITISM

The exact nature of parasitism, its origin and modifications, is naturally of the utmost significance to pathology. This problem can perhaps be attacked with the greatest promise of successful solution in those cases which appear to be near the border line between saprophytic and the parasitic species. If we admit that evolutionary processes are still active, there seems no reason to doubt that parasites are at present in process of evolution. Whether this evolution is brought about by mutation or by a gradual accumulation of slight variations or by some other process or complex of processes not yet discovered, it would seem possible to get further light on this subject by a thorough investigation and comparison of some of the active parasitic Ascomycetes and their near relatives which seem to be saprophytic or only very weakly parasitic. A striking example of this condition of affairs is presented by the genus *Endothia* already referred to. *Endothia parasitica* is a most virulent parasite, whereas its near relative, *E. radicalis*, which occurs on the same host, shows little or no parasitic tendencies, while some of the other species show slight indications of parasitism.

ECOLOGY

In this connection it may be well to call attention to the great possibilities in the study of the ecology of the fungi. At present, unfortunately, there is little exact knowledge of the distribution and environmental relations of fungi. The exact limits of distribution of but very few species is known, and in fact the exact identity of many species is still doubtful. The question of their host relations is also not well understood except in the case of the rusts, smuts and powdery mildews. Our studies of *Endothia* appear to indicate that, in this group at least, the species have very definite geographical ranges which are not determined by their host relations, but apparently are very intimately associated with climatic and other environmental conditions, as well as competition with other fungi. All these things are of vital interest to the pathologist, especially in connection with the possibilities in the way of the spread of any particular parasite, or in determining the probable behavior of any foreign species which might be introduced. To know what fungi exist in any region and what their natural distribution and host relations are, is of the utmost importance in devising ways and means to prevent their introduction into other countries. In this connection I may quote from Winthrop Sargent in the Final Report of the Pennsylvania Chestnut Tree Blight Commission, 1914, page 12, as he presents the case in a very plain and forceful manner:

> In conclusion, it seems necessary to call sharp attention to the real lesson to be learned from the chestnut blight epidemic—viz.: the necessity of more scientific research upon problems of this

character; to be undertaken early enough to be of some value in comprehending, if not controlling the situation. We have seen that the blight might have been kept out of the country in the first place by inspection, or, once in, that it might have been destroyed, or at least checked, before it had gotten widely distributed. But instead it was permitted to enter, and to spread for many years without scientific notice, and for several more years without any organized attempt to control it, or even to study it seriously. Are we doing any better now with reference to the future?

GENETICS

While perhaps not having the same direct bearing upon pathological problems, still it may be worth pointing out that fungi appear to offer one of the simplest and easiest points of attack on the general problems of evolution, such as mutation, variation, and inheritance; in fact, the various problems of genetics. Here we have organisms comparatively simple in structure, either asexual or at least not complicated by possible hybridization and capable of rapid reproduction and cultivation under controlled conditions.

Coming finally to questions of prevention and control of diseases caused by parasites, it is only stating a truism to say that whatever success may be attained in this direction must depend chiefly upon the completeness of our knowledge of the parasite in all its aspects and relations.

Finally, mycologists, pathologists and all real scientists are searchers after truth. This implies not only large opportunities, but also obligations. "Noblesse oblige" is particularly applicable to the scientist. In these days of storm and stress it is, if possible, more important than ever that we should live up to the highest ideals of truth, and make individual and united effort to establish the universal reign of justice, peace, and brotherly love among mankind.

An excellent example of what the scientist should strive to be in all his human relations has been given us by Professor Charles E. Bessey, the distinguished botanist and beloved teacher, whom death has so lately taken from us. He not only sought truth and taught truth, but lived it, making the world not only wiser and richer, but better. May we all leave as noble a record when called to lay life's burdens down.

C. L. Shear

EDWARD WESTON'S INVENTIONS

The pioneer work of Dr. Edward Weston is not easy to describe in a few words. His restless inventive activity has been spread over so many subjects, has intertwined so many interlocking problems, that in order to understand its full value, it would be necessary to enter into the intimate study of the various obstacles which opposed themselves to the development of several leading industries which he helped to create: the electro-deposition of metals, the electrolytic refining of copper, the construction of electric generators and motors, the electric illumination by arc- and by incandescent-light, and the manufacture of electrical measuring instruments. An impressive list of subjects, but in every one of these branches of industry, Weston was a leader, and it was only after he had shown the way in an unmistakable manner, that the art was able to make further progress and develop to its present-day magnitude.

But why was Weston able to overcome difficulties which seemed almost unsurmountable to his predecessors and coworkers in the art?

The answer is simple: He introduced in most of his physical problems a chemical point of view—a chemical point of view of his own; a point of view which was not satisfied with general statements, but which went to the bottom of things. He did not

get his chemistry wholesale as it is dispensed in some of our hot-bed-method educational institutions. He had to get at his facts piecemeal, one by one, adjust them, ponder over them—collect his facts with much effort and discrimination; he did not acquire his knowledge merely to pass examinations, but to use it for accumulating further knowledge.

It seems rather fortunate for him that one of the first employments he got in New York was with a chemical concern which made photographic chemicals. This was the time of the wet-plate, when photographers made their own collodion, their own silver bath, their own paper. Whoever went through those delicate operations knew the difficulties, the uncertainties which were caused by small variations in the composition of chemicals or in the way of using them. Photochemistry is excellent experience for any young chemist who is disposed to generalize too much all chemical reactions by mere chemical equations. Whoever has to deal with those delicate chemical phenomena, which occur in the photographic image, knows that many unforeseen facts can not easily be accounted for by our self-satisfying but often superficial generalizations of the text-books.

Weston's tendency to observe small details in chemical or physical phenomena led him to improve the art of nickel-plating and electrolytic deposition of metals to a point where it entered a new era. When he undertook the study of the difficulties in this art, he took nothing for granted, but by close observation he succeeded in devising methods not only of improving the physical texture of the deposit, but for increasing enormously the speed and regularity with which the operations could be carried out; all these improvements are now embodied in the art of electro-typing, nickel-, gold- and silver-plating.

At this time, attempts had already been made for the commercial refining of copper by means of the electric current. But this subject was then in its first clumsy period, far removed from the importance it has attained now amongst modern American industries. Here again, Weston brought order and method, where chaos reigned. His careful laboratory observations, harnessed by his keen reasoning intellect, established the true principles on which economic, industrial, electrolytic-copper-refining could be carried out. Professor James Douglass[1] referred to this fact in a recent address:

> I suppose I may claim the merit of making in this country the first electrolytic copper by the ton, but the merit is really due him (Weston) who in this and innumerable other instances, has concealed his interested work for his favorite science and pursuits under a thick veil of modesty and generosity.

The whole problem of electrolytic refining, when Weston took it up, was hampered by many wrong conceptions. One of them was that a given horsepower could only deposit a maximum weight of copper regardless of cathode- or anode-surface. This fallacious opinion was considered almost an axiom until Weston showed clearly the way of increasing the amount of copper deposited per electrical horsepower, by increasing the number and size of vats and their electrodes, connecting his vats in a combination of series and multiple, the only limit to this arrangement being the added interest of capital and depreciation on the increased cost of more vats and anodes, in relation to the cost of horsepower for driving the dynamos.

The electro-deposition of metals forced Weston into the study of the construction of dynamos. Until then, the electric cur-

[1] Commencement address, Colorado School of Mines, *Metallurgical and Chemical Engineering*, Vol. XI., No. 7, July, 1913, page 377.

rent used for nickel-, silver- and gold-plating, as well as for electro-typing, was obtained from chemical batteries. Weston says that it was almost a hopeless task to wean electroplaters from these cells to which they had become tied by long experience and on the more or less skillful use of which they based many of the secrets of their trade.

If the dynamo as a cheap and reliable source of electric current was advantageous for nickel-plating, it became an absolutely indispensable factor for electrolytic copper refining. At that time, the dynamo was still at its very beginning—some sort of an electrical curiosity. It had been invented many years before by a Norwegian, Soren Hyjorth, who filed his first British patent as far back as 1855. Similar machines had been built both in Europe and America, but little or no improvement was made until Weston, in his own thorough way, undertook the careful study of the various factors relating to dynamo efficiency.

In 1876, Weston filed his first United States patent on rational dynamo construction, which was soon followed by many others, and before long he had inaugurated such profound ameliorations in the design of dynamos that he increased their efficiency in the most astonishing manner. Heretofore, the dynamos which had been constructed showed an efficiency not reaching over fifteen to forty per cent., gross electrical efficiency, but the new dynamos constructed after Weston's principles increased this to the unexpected efficiency of ninety-five per cent., and a commercial efficiency of eighty-five to ninety per cent. He thus marked an epoch in physical science by constructing the first industrial machine which was able to change one form of energy, motion, into another, electricity, with a hitherto unparalleled small loss. As the improvements in dynamos depend almost exclusively on physical considerations, and have little relation with the field of chemistry, I shall dispense with going further into this matter. But I should be permitted to point out that the first practical application of electrical power transmission for factory purposes in this country, was first utilized in Weston's factory; the success of this installation induced the Clark Thread Works, also located in Newark, to adopt this method of power transmission for some special work; a method which now has become so universal. For this purpose, Weston had to invent new devices for starting, and for controlling, as well as for preventing injuries to motors by overload.

In Weston's factory also the electric arc was used for the first time in the United States for general illumination.

In fact, from 1875 to 1886, Weston was very energetically engaged with the development of both systems of arc- and incandescent-illumination by electricity. We see him start the manufacture of arc-light-carbons according to methods invented by him, and thus he became the founder of another new industry in America. He continued this branch of manufacture until 1884, at which epoch this part of the business was transferred to another company, which has made a specialty of this class of products, and has developed it into a very important industry. Here again, Weston introduced chemical methods and chemical points of view. Amongst the many objections which the public had against the electrical arc was the bluish color of its light. Women especially complained that the blue-violet light did not bring out their complexion to the best advantage. Weston first tried to use shorter arcs which gave a whiter light, but this was only a partial remedy. He soon found a more radical

and more complete cure by the introduction of vapors of metals or metallic salts or oxide in the arc itself, so as to modify at will the color of the light, and thus he became the inventor of the so-called "flaming arc." It is noteworthy that it took about twenty years before electricians and illuminating engineers became so convinced of the advantages of the flaming arc, that it had to be "reinvented" during these late years, and now it is considered the most efficient system of arc-illumination.

In relation to this invention, it is interesting to quote the following extract of the specifications from his United States Patent 210,380, filed November 4, 1878:

> This rod or stick may be made of various materials, as, for example, of so-called "lime glass," or of compounds of infusible earths and metallic salts, silicates, double silicates, mixtures of the silicates with other salts of metals, fluorides, double fluorides, mixtures of the double fluorides, fusible oxides, or combinations of the fusible oxides with the silicates—the requirements, so far as the material is concerned, being that it shall be capable of volatilization when placed on the outer side of the electrode to which it is attached, and that its vapor shall be of greater conductivity than the vapor or particles of carbon disengaged from the carbon electrodes. The foreign material added to the carbon may be incorporated into the electrode by being mixed with the carbon of which the electrode is composed, or it may be introduced into a tubular carbon; but I have found it best to place it in a groove formed longitudinally in the side of the electrode, as shown.

In his endeavors to make the electric incandescent lamp an economic possibility, we see him introduce over and over again, chemical methods and chemical considerations. He first tried to utilize platinum and iridium, and their alloys, which he fused in a specially constructed electric furnace, devised by him, antedating the furnace described by Siemens. This is probably the first electrical furnace, if you will except the furnace which Hare used in his laboratory in Philadelphia.

But these platinum metals showed serious defects aside from their high cost, and by that time, Weston had become so familiar with the properties of good carbon that like other inventors, he became convinced that the ultimate success lay in that direction.

And now we see him join in that race of rivalry among inventors who all engaged their efforts in search of the real practical incandescent lamp. Among this group of men, the names of Edison here in the United States and that of Swan in England, have been best known. To go in the details of this struggle for improvement is entirely outside of the scope of this short review.

Edison succeeded in making incandescent lamp filaments by carbonizing selected strips of bamboo. But even a carbon made of this unusually compact and uniform material was far from being sufficiently regular and homogeneous. Indeed, all the then known forms of carbon conductors had the fatal defect of a structural lack of homogeneity. On account of this, the resistance varied at certain sections of the filament, and at these very spots, the temperature rose to such an extent that it caused rapid destruction of the filament; this is somewhat similar to the chain which is just as strong as its weakest link.

These irregularities in the filament reduced enormously the term of service of any incandescent lamp. Weston tried to solve this difficulty by means of his chemical knowledge. He remembered that as a boy, when he went to visit the gas works to obtain some hard carbon for his Bunsen cell, this carbon was collected from those parts of the gas retort which had been the hottest, and where the hydrocarbon gas had undergone dissociation, leaving a dense deposit of coherent carbon.

In this chemical phenomena of dissociation at high temperature, he perceived a

chemical means for "self-curing" any weak spots in the filament of his lamp. The remedy was as ingenious as simple. In preparing his filament, he passed the current through it while the filament was placed in an atmosphere of hydrocarbon gas, so that in every spot where the temperature rose highest on account of greater resistance, brought about by the irregular structure of the material, the hydrocarbon gas was dissociated and carbon was deposited automatically until the defect was cured, with the result that the filament acquired the same electric resistance over its whole length. But this invention, however brilliant, did not limit his efforts. He had become imbued with the idea that the ideal filament would be an absolutely structureless, homogeneous filament, with exactly the same composition and the same section throughout its whole length. He reasoned that such a filament could not be obtained from any natural products, neither from paper nor bamboo, but that it had to be produced artificially in the laboratory from an absolutely uniform, structureless chemical substance. After various unsuccessful attempts, he finally secured this result by applying his old knowledge of the days when he used to make collodion. He produced a homogeneous, structureless transparent film of nitrocellulose by evaporating a solution of this material in suitable solvents. As he could not carbonize this film on account of the well-known explosive properties of so-called "gun-cotton," he obviated this difficulty by eliminating the nitrate group of the molecule of cellulose-nitrate by means of ammonium-sulphydrate. This gave him a flexible, transparent sheet, very similar in appearance to gelatine; this material he called "Tamidine." Such films could be cut automatically with utmost exactitude, producing filaments of uniform section, which then could be submitted to carbonization, before fastening them to the inside of the glass bulb of the incandescent lamp.

It is interesting to note here that the modern Tungsten lamp, in all its perfection, made of ductile tungsten, is after all, the fullest development of the principle of an entirely structureless homogeneous chemical filament. The Tungsten-filament can stand much higher temperatures than carbon and this property gives it higher lighting efficiency, but the former tungsten filaments of a few years ago, which had a granular structure, had the same defect as the earlier carbon lamps, namely, a non-homogeneous texture and correspondent short life.

While Weston was wrestling with all his electrical problems, and more particularly with the construction of dynamos and motors, he was handicapped continuously by the clumsy and time-consuming methods of electrical measurements which were the best existing at that period. Up till then, these methods had been found good enough for physical laboratories, where the lack of accuracy did not result disastrously in hitting the pocket of the manufacturer, or where time—abundant time for observations and calculations—was always available. But progress in the electrical industries lagged behind the delay and uncertainties caused by electrical measurements. So Weston was compelled to invent for his own use a set of practical electrical measuring instruments. It was not long before some of his friends wanted very badly duplicates of his instruments; before he knew it, he was giving considerable attention to the construction and further development of these instruments. Just about this time, the electric light and dynamo construction enterprise entered into a new period, where they began to develop in large unwieldy commercial organiza-

tions, requiring public franchises and which had to be backed by vast amounts of new capital. In its boards of directors, business men, or financial men and corporation lawyers, became paramount factors and eclipsed in importance the technical or scientific men, who, in earlier days, had almost exclusively contributed to the development of the art.

Following his natural inclinations, Weston soon abandoned his former business connections in order to entrench himself in a field where individuality, science and technology were of almost unique importance, and which he could develop without the necessity of incurring financial obligations beyond what he could master personally. Thus he dropped his connections with the electric light and dynamo enterprises, and we see him now, heart and soul, in another new industry which he created—the art of making accurate, trustworthy and easy-to-use electrical measuring instruments. Did he foresee at that time that this art would attain the magnitude to which he has brought it to-day? Did he dream that his early modest shop was to develop into one of the most remarkably equipped factories in the world; an institution which seems the embodiment of what industrial enterprises may look like in future days, when scientific and liberal-minded management will have become the rule instead of the exception?

In his factory in Newark, Weston seems to have instilled some of his own reliability and accuracy in the minds of the men and women he employs.

In fact, has it occurred to you that even a man with the widest knowledge and the highest intelligence, who is not scrupulously reliable and careful, who is not the soul of honesty personified, could not make honest and trustworthy measuring instruments nor create reliable measuring methods?

What Stas did in chemistry for atomic weights, Weston did for electrical measuring; he created radically new methods of measurement, and introduced an accuracy undreamt of heretofore. Do not forget that his problems were not easy ones. When the British government offered a prize of $100,000 for the nearest perfect chronometer, the problem of a reliable chronometer involved considerably less difficulties and fewer disturbing factors than any of those encountered in devising and making electrical measuring instruments. But here again, even at the risk of monotonous repeating, I want to impress you with the fact that the success of the methods of Weston was found in almost every case in the application of chemical means by which he tried to solve his difficulties.

When he took up this subject, the scientists, as far back as 1884, accepted implicitly the belief that the definition of a metal and a non-metal resides in a physical distinction; that for metals the electrical resistance increased with temperature, while for non-metals, their resistance decreased with temperature. This was another one of those readily accepted axioms which nobody dared to refute or contest because they were repeated in respectable text-books. And yet, this unfortunate behavior of metals was the greatest drawback in the construction of accurate measuring instruments. Indeed, on account of the so-called temperature coefficients, all measurements had to be corrected by calculation to the temperature at which the observation was made. This seems easy enough, but it was time-consuming and often it is more difficult to make rapid accurate observation of the temperature of the instrument itself. First of all, the thermometers are not accurate, and have to be corrected periodically, and furthermore, it is not an easy matter to determine rapidly the temperature of a coil or an instrument. Moreover, by the

very passage of the electric current, fluctuating changes in temperature are liable to occur, which would make the observations totally incorrect. All this led to hesitation and slowness in measurements. Weston wanted to correct this defect, but he was told that the very laws of physics were against his attempts. Before he was through with his work, he had to correct some of our conceptions of the laws of physics; now let us see how he did it:

Weston knew that the favorite metal for resistances was so-called German-silver. Strange to say, he was the first one to point out to the Germans themselves that "German-silver" is a word which covers a multitude of sins, and that the composition of German-silver varies considerably according to its source of supply. The result was that he soon proposed a standard-copper-and-nickel-and-zinc-alloy containing about 30 per cent. of nickel, and which had a resistance of almost twice that of ordinary German-silver and a much lower temperature coefficient. Not satisfied with this, he took up the systematic study of a large number of alloys. The first batch which he undertook to study amounted to more than three hundred different alloys. Since that time, he has considerably increased this number, and is still busy at it. Every one of these alloys he made himself in his laboratory, starting from pure materials, and controlling the whole operation from the making of the alloy to the drawing of wires of determined size. By long and repeated observations, on which many years have been consumed, he was able to determine the electrical behavior of each one of these alloys at different temperatures. After awhile, he began to observe remarkable properties in some manganese alloys he compounded. He managed to produce an alloy which had sixty-five times the resistance of copper. But getting bolder and bolder, he strove to obtain an alloy which had no temperature-coefficient whatever. He not only succeeded in doing this, but finally produced several alloys which had a *negative* temperature-coefficient. In other terms, their resistance, instead of increasing with rise of temperature, decreased with increasing temperature. He also showed that the resistance of these alloys depended not only on their composition, but on certain treatments which they undergo, for instance, preliminary heating. And since that day, the physicists have had to bury their favorite definition of metals and non-metals. The present generation can hardly realize what this discovery meant at that time. I could not better illustrate this than by reminding you of the fact that in 1892, at the meeting of the British Association for the Advancement of Science, where it was urged to found an institution similar to the Deutsche Reichsanstalt, Lord Kelvin said in his speech:

> The grand success of the Physikalishe-Reichsanstalt may be judged to some extent here by the record put before us by Professor von Helmholtz. Such a proved success may be followed by a country like England with very great profit indeed. One thing Professor von Helmholtz did not mention was the discovery by the Anstalt of a metal whose temperature coefficient with respect to electrical resistance is practically nil; that is to say, a metal whose electrical resistance does not change with temperature. This is just the thing we have been waiting for for twenty or thirty years. It is of the greatest importance in scientific experiments, and also in connection with the measuring instruments of practical electric lighting, to have a metal whose electrical resistance does not vary with temperature; and after what has been done, what is now wanted is to find a metal of good quality and substance whose resistance shall diminish as temperature is increased. We want something to produce the opposite effect to that with which we are familiar. The resistance of carbon diminishes as temperature increases; but its behavior is not very constant. Until within the last year or so nothing different was known of metals from the fact that elevation of temperature had the ef-

fect of increasing resistance. The Physikalische-Anstalt had not been in existence two years before this valuable metal was discovered.

Then followed this colloquy:

PROFESSOR VON HELMHOLTZ. The discovery of a metal whose resistance diminished with temperature was made by an American engineer.

PROFESSOR AYRTON. By an Englishman—Weston.

LORD KELVIN: That serves but to intensify the position I wished to take, whether the discovery was made by an Anglo-American, an American-Englishman, or an Englishman in America. It is not gratifying to national pride to know that these discoveries were not made in this country.

The misinformation of Kelvin was due to the fact that after the Weston patents had been published, his alloy was called *manganin* in Germany, and a good deal of publicity had been given to its properties with scant reference to its real inventor, an occurrence which, unfortunately, is not infrequent not only among commercial interests but in technical or scientific circles as well.

No less important was the invention of the Weston cell, which in 1908, by the international commission for the establishment of standards of electrical measurements, has become the accepted universal practical standard for electromotive force. Here again, this physical standard was obtained by chemical means.

Until Weston researches on standard cells, the Clark cell had been the standby of the electricians and electrochemists of the world, as the standard of electromotive force. It required the keen analysis of a Weston to ascertain all the defects of this cell and to indicate the cause of them. Later, he drew from his careful chemical observations, the means to construct a cell which was free from the defects of its predecessors—a cell that had no temperature-coefficient and had no "lag."

He detected that the choice of a saturated solution of sulphate of zinc in which was suspended an excess of crystals of this salt, was an unsuitable electrolyte and one of the principal causes why the indications of the Clark cell varied considerably with the temperature. It is true that this could be obviated by placing the cell in a bath of constant temperature. But this involves new difficulties due to the proper determination of the real temperature. Furthermore, there is always a "lag" in the indications due to the fact that at varying temperatures it requires a certain time before the solution of the salt has adjusted itself to the coefficient of saturation for each newly acquired temperature. By studying the comparative behavior of various salts at different temperatures, he came to the conclusion that cadmium-sulphate is more appropriate and this was one of the several important improvements he introduced in the construction of a new standard of electromotive force.

Dr. Weston assures me that he has succeeded in making his alloys to show only a change of one millionth for a variation of one degree centigrade. The metallic alloys he discovered are used practically in nearly all kinds of electrical measuring instruments throughout the world. Weston instruments and Weston methods are now found in all properly equipped laboratories and electrochemical establishments of the world. On a recent trip to Japan, I saw them in the University of Tokio, as well as in the Japanese war museum, where their battered remains attested that the Russians used them on their captured battleships. I have worked in several laboratories in Europe equipped with instruments said to be "just as good" as those of Weston, but in most instances, they were imitations of Weston instruments and it was significant that they kept at least one Weston instrument to be used to correct and compare their national product.

Like many inventors, Weston has been engaged extensively in patent litigation. To uphold some of his rights, he had to spend on one set of patents nearly $400,000, a large amount of money for anybody, but as he told me, he begrudges less the money it cost him than all his valuable time it required—a greater loss to an inventor thus distracted from his work. What is worse, most of this litigation was so long-winded that when finally he established his rights, has patents had aged so much that they had lost, in the meantime, most, if not all, of their seventeen years' terms of limited existence. And here I want to point out something very significant. In the early periods of his work, between 1873 and 1886, Weston took out over three hundred patents. Since then, he has taken considerably less, and of late, he has taken out very few patents—after he became wiser to the tricks of patent infringers. Formerly, as soon as he published his discoveries or his inventions, in his patent specifications, he was so much troubled with patent pirates that instead of being able to attend to the development of his inventions, he was occupied in patent litigation. As an act of self-preservation, he has had to adopt new tactics. He now keeps his work secret as long as possible, and in the meantime, spends his money for tools and equipment for manufacturing his inventions. In some instances, this preparation takes several years. Then by the time he sends any new type of instruments into the world, and others start copying, he has already in preparation so many further improvements that pretty soon the next instrument comes out which supersedes the prior edition. He had to utilize these tactics since he found how impractical it was to rely on his patent rights for protection. That inventors should have to proceed in this way is certainly not a recommendation for our patent system; it kills the very purpose for which our fundamental patent law was created, namely, *the prompt publication of new and useful inventions.*

L. H. Baekeland

NOTE ON THE ORBITS OF FREELY FALLING BODIES

In No. 975, Vol. XXXVIII., N.S. (September 5, 1913), of this journal, I gave a semi-popular account of an investigation on "The orbits of freely falling bodies" published in Nos. 651, 652 of the *Astronomical Journal,* August 4, 1913. Soon after the appearance of these papers several correspondents challenged the result I derived for the meridional deviation of the falling body, all of them maintaining that this deviation is toward the equator instead of away from it, as I had concluded. Being preoccupied with affairs somewhat remote from the fields of mathematical physics, I have not been able to give this apparent discrepancy adequate attention, although its origin was indicated in an informal communication to the Philosophical Society of Washington in April, 1914.

In the meantime, two noteworthy contributions to the already extensive literature of this subject have been published by Professor F. R. Moulton[1] and by Professor Wm. H. Roever,[2] respectively. These contributions are not only important for originality of methods and for painstaking attention, especially to mathematical details, but they may seem to the casual reader to have exhausted the subject by demonstrating in the most approved mathematical fashion of our day that the postulates

[1] "The Deviations of Falling Bodies," *Annals of Mathematics,* Second Series, Vol. 15, No. 4, pp. 184–94, June, 1914. This investigation is specially remarkable in that but one kind of latitude is used. It is likewise remarkable in that no explicit statement is made as to which of the various latitudes (astronomic, geocentric, geodetic or reduced) is used.

[2] "Deviations of Falling Bodies," *Astronomical Journal,* Nos. 670–672, pp. 177–201, January 22, 1915.

adopted and the results derived are at once unique, "necessary" and "sufficient." Both authors insist with much particularity that the discrepancy between us is due to superior methods of approximation followed by them in integrating the fundamental equations of motion, since we all agree on the forms of these equations.

But the subject is not thus easily disposed of. A sense of humor should lead us to inquire whether the parties concerned have all solved the same problem. The answer to such an inquiry in this case is that while all have ostensibly treated the same problem, two different problems have actually been solved. We have thus developed a fresh illustration of a common danger in mathematical physics, namely, that of fixing attention on mathematical perfection before adequate regard has been given to physical requirements.

It would be out of place in the columns of this journal to enter into a review of the details of the investigations of Professor Moulton and Professor Roever. Such a review is, in fact, neither desirable here nor essential in a technical publication. The source of the discrepancy referred to is so evident that it needs only to be stated to be appreciated; and once stated there is no ground for controversy in this part of the subject. It appears desirable, however, to refer in some detail to the general considerations involved in deriving the orbits of falling bodies as well as to those special considerations which determine meridional deviations. For this purpose it will be essential in a limited degree to use the abridged language of analysis.

But before adducing these considerations I wish to plead guilty to an oversight in reading Professor Roever's earlier papers[3] and to submit a brief of extenuating circumstances. At first reading of these papers it appeared to me that he had neglected terms involving the square of the angular velocity of the earth in his equations of motion of the falling body. These terms do not appear explicitly in those equations, but only implicitly through a special potential function used by him for the first time, apparently, in this connection. Not being able to follow his derivation of these equations (if, indeed, he may be said to have derived them in the mechanical sense), I assumed them to be identical in meaning, as they are in form, with those published by several earlier writers. This assumption was supported by uncertainty as to meaning and by lack of homogeneity of his expression for the potential function introduced on page 342 of his first paper; and still more by his identification of astronomic with geocentric latitude (on p. 339, same paper) by means of the loose phrase "with sufficient approximation." A similar lack of "accuracy and precision" will be found in several parts of his latest paper cited above. See, for example, his equations (j), wherein he confounds geocentric with reduced latitude; also p. 199, where he identifies his equations (38) and (41) with my equation (26) and makes with respect to them the surprising statement that "it is, of course, evident that this function corresponds to some distribution of revolution" in the earth's mass. Concerning the absence of validity for this latter statement some remarks are made below.

Now, to account for the discrepancy in question, namely, our differing values for the meridional deviation of the falling body, it is only essential to observe that two different surfaces of reference have been used. Professors Moulton and Roever have referred the motion to a geoid specified by a certain approximate potential function, while I have referred the same motion to Clarke's spheroid of revolution (of 1866), which is determined by certain axes (a, b) dependent on geodetic measurements. These surfaces are not coincident to the order of approximation adopted by either party, and the discrepancy developed appears to be both "necessary" and "sufficient" to restore confidence in the mathematical mills of all concerned.[4]

[3] "The Southerly Deviation of Falling Bodies," *Transactions of the American Mathematical Society*, Vol. XII., pp. 335–53. "The Southerly and Easterly Deviations of Falling Bodies for an Unsymmetrical Gravitational Field of Force," *Ibid.*, Vol. XIII., pp. 469–490.

[4] It has been known since the earlier writings of Airy that the geoid and the spheroid are not coincident, but I was not aware that their inclination

To put this statement in a clearer form for the mathematical reader, let V denote the gravitational potential per unit mass at a point outside, or on, the earth, and let r and ψ denote, respectively, the radius vector and the geocentric latitude of that point. Then, if ω denote the angular velocity of the earth and if the point (r, ψ) is attached to and rotates with the earth, the expression

$$V + \tfrac{1}{2}\,\omega^2 r^2 \cos^2 \psi$$

is the potential per unit mass at that point due to the attraction and to the rotation of the earth. Calling this expression U,

$$U = V + \tfrac{1}{2}\,\omega^2 r^2 \cos^2 \psi = cons't \qquad (1)$$

specifies a family of equipotential surfaces about the earth. Thus, for example, $U = constant$ specifies the sea surface, provided V, r, ψ have appropriate values, and this surface, which may be imagined to extend through the continents, is called the geoid. Similarly, corresponding surfaces above and below the sea surface are geoidal and may be used, like the sea level, as surfaces of reference.

Adopting for the moment the simpler hypothesis that the shape of the geoid does not depend on longitude, the divergence from parallelism of the geoid (1) and the spheroid (a, b) may be defined in the following manner. Since the linear acceleration components along and perpendicular to the radius vector r at the point (r, ψ) of the geoid $U = constant$ are, respectively,

$$\frac{\partial U}{\partial r} \quad \text{and} \quad \frac{\partial U}{r\partial \psi},$$

the tangent of the angle between r and the normal to the geoid at the same point is given by the quotient of the second by the first of these partial derivatives.[5]

The angle thus derived is the difference between the astronomical latitude, ϕ_0, say, and the geocentric latitude ψ of the point (r, ψ). Using the data for V and r adopted in my paper cited above, it is found that the general value of this difference is to the first order of approximation, and in seconds of arc,

$$\phi_0 - \psi = 688'' \sin 2\phi_0. \qquad (2)$$

On the other hand, the difference between the geodetic latitudes ϕ, say (determined by the normal to the spheroid (a, b)), and the geocentric latitude of the same point, is to the same order of approximation

$$\phi - \psi = 700'' \sin 2\phi. \qquad (3)$$

There is thus a systematic difference between these two quantities, since the residuals $(\phi_0 - \phi)$, or the so-called plumb-line deflection in the meridian, are assumed to be of compensating plus and minus magnitudes in determining the spheroid (a, b). Otherwise expressed, this systematic difference is such as to make the value of the meridional deviation of the falling body vanish to terms of the order of ω^2 inclusive, adopted in my investigation, if reference is made to the geoid instead of to the spheroid; and to this order of approximation the discrepancy is completely accounted for.

It is evident that we may not discard either in favor of the other, of the two surfaces of reference giving rise to this discrepancy, since their departure from coincidence is an index of our ignorance of the geoid especially and to a less extent also of the spheroid used. The geoid specified by equation (1) is obviously less well known than the spheroid, since an assumption must be made concerning the distribution of density in the earth before the moments of inertia which determine the geoid can be computed. Thus the relation (2) is known with less precision than the relation (3); but it is now clear that a complete treatment of the problem in question requires that both of these relations be taken into account along with the additional relations $(\phi_0 - \phi)$ and $(\lambda_0 - \lambda)$, say, or the plumb-line deflections in latitude and longitude, respectively, at the point (r, ψ, λ). That considerable uncertainty attaches still to the relation (3) is indicated by the range in the following values for the coefficient of sin 2ϕ derived by some earlier and by some more recent writers in geodesy.

could figure sensibly in the orbits of falling bodies when my first investigation of these orbits was published.

[5] To terms of the order of ω^2 inclusive this tangent, using the notation of my paper cited above, is

$$\frac{\tfrac{1}{2} r \left(\omega^2 + \dfrac{3\beta}{r^5}\right) \sin 2\psi}{\dfrac{\alpha}{r^2} + \dfrac{3\beta}{2r^4}(1 - 3 \sin^2 \varphi) - \omega^2 r \cos^2 \psi}.$$

1841	690.6″
Clarke, 1866	700.4″
Harkness, 1891	688.2″
Hayford, 1909	695.8″

It appears essential in this connection to call attention to a common misapprehension with respect to the earth which Professors Moulton and Roever have helped to disseminate by their able contributions to the subject before us. The potential function V which appears in equation (1) above, may be developed in a series of spherical harmonics whose first three terms are given in the second member of the following equation:

$$V = \frac{Mk}{r} + \frac{k}{2r^3}\{C - \tfrac{1}{2}(B + A)\}(1 - 3\sin^2\psi) + \frac{3k}{4r^3}(B - A)\cos^2\psi\cos 2\lambda. \tag{4}$$

In this r, ψ, λ are, respectively, the radius vector, geocentric latitude and longitude of the point, outside the earth, to which V applies. M is the mass of the earth, k is the gravitation constant and A, B, C are in order of increasing magnitude the moments of inertia of the earth with respect to a set of principal axes originating at its centroid. C is commonly said to be the moment with respect to the axis of rotation of the earth, but in these days of "variation of latitudes" and of "mathematical rigor," it should be said to apply to the axis of figure nearest the axis of rotation. A and B are then the moments with respect to the principal axes in a plane through the centroid and normal to the axis of C, or in the plane of the equator as we commonly say.

The expression (4) has very remarkable properties. It is equation (26) of my paper cited above. The value of V is the same whether the latitude ψ is positive or negative; and dependence on longitude vanishes if $B = A$. With respect to this equation Professor Moulton remarks "If the rotating body is a figure of revolution about the axis of rotation whose density does not depend upon the longitude, the function V can be developed as a series of zonal harmonics in the form

$$V = \frac{\alpha}{r} + \frac{\beta}{r^3}(1 - 3\sin^2\varphi)."$$

A similar remark with regard to this expression has been quoted above from Professor Roever, the inference being, apparently, that in some manner the expression (4) limits the distribution of the earth's mass to one of revolution. As a matter of fact, however, the expression (4) implies no such restriction; on the contrary, it applies equally to a body of any form and of any distribution of density, the sole requirement being that the point (r, ψ, λ) lie at a distance from the centroid of the body equal to or greater than the greatest distance of any element of mass in the body from the same point. The considerations which permit us to assume $(B - A)$ small, or possibly negligible, in this and other problems of geodesy, must depend, unfortunately, on other sources of information than the expression (4). Some attention to these considerations was given in each of my papers referred to in the first paragraph of this note.

Without going further into the subject at this time it may suffice to remark that it now appears illusory except as a mathematical exercise to push the solution of the differential equations of motion of a falling body to terms involving the second derivatives of V without including the third term in the right-hand member of (4), without taking account of the known relation between these derivatives, and without taking account of plumb-line deflections, which often exceed the discrepancy shown by equations (2) and (3).

R. S. WOODWARD

February 22, 1915

ARTHUR VON AUWERS

THE problems that confront the astronomer differ from those with which workers in other departments of science are engaged in many important particulars, but in none more than in the magnitude of the data involved. So great is the number of the stars, so vast, both in space and in time, the scale of their motions, that in general it transcends the powers of an individual, or even of a single observatory, to collect, within the span of a lifetime, the materials for comprehensive studies, or to collate and discuss them. Cooperation is probably

more essential to progress in astronomy than in any other science.

The earliest example of cooperation on a large scale in astronomical research was the proposition brought forward by Argelander and his associates, half a century ago, for the formation of a great catalogue of all the stars to the 9th magnitude in the northern sky. At the meeting of the Astronomische Gesellschaft in 1869, when, after four years of preliminary discussion, the project was formally initiated, the plan of work adopted was the one presented by Dr. Arthur Auwers, a young astronomer, who, three years earlier, had been elected to membership in the Berlin Academy of Sciences to fill the place left vacant by the death of Encke. In view of Auwer's youth—he was then only 31—this was a notable recognition of his ability. But even more significant was the fact that to him was also entrusted the all-important duty of preparing the system of fundamental star places which provided the foundation for the entire work.

It is impossible, without running unduly into technicalities, to give an adequate idea of the difficulties attending the construction of such a fundamental system of star places. It must suffice to say that it requires the highest order of ability, a profound grasp of the principles of gravitational astronomy, a comprehensive knowledge of star catalogues, rare judgment, and a mastery of detail that is given to but few minds. How well qualified Auwers was for the responsibility placed upon him is evident from the fact that the fundamental system he elaborated more than 40 years ago is adopted, in all its essentials, as the foundation of the greater part of the most refined meridian circle work of the present day.

His connection with the "Astronomische Gesellschaft Catalogue" did not end with the service I have described. In addition, he undertook the observation of one of the sections or "Zones" of the catalogue—producing a model work—and was soon made chairman of the commission in charge of the entire project —a position he held to the date of his death, January 24, 1915. Its success, therefore, is in large measure due to his careful planning and wise guidance. Long before his death he had the satisfaction of seeing the original catalogue completed by contributions from no less than twelve great observatories in Europe and America, and of having the plan extended, again under his direction, well into the Southern Hemisphere.

G. F. J. Arthur Auwers was born in Göttingen in 1838 and received his early education in the schools of his native city. His interest in astronomy was manifested when he was still a mere boy, and even before he received his doctor's degree at Königsberg in 1862, he had made many important contributions to it both by observations and by theoretical investigations. His dissertation for the doctorate, on the variable proper motion of Procyon, placed him at once in the front rank of astronomers. In this research he struck the keynote of his future life-work, "the treatment of all questions concerning the positions and motions of the stars."

I shall not attempt even to enumerate his many contributions to this department of astronomy. His services to the A. G. Catalogue have already been mentioned. It must suffice to describe briefly one other research, in many respects his most important—the new reduction of the Bradley stars.

The fundamental data upon which all studies of the mechanics of the stellar universe depend are the positions of the stars on the celestial sphere, their apparent motions on this sphere (technically, their "proper motions"), their radial velocities and their distances. The first two of these elements are derived from the star catalogues based on meridian observations. One of the most important of all star catalogues is that based upon the observations of Bradley, at Greenwich, about the middle of the eighteenth century, for these observations were the first that are at all comparable in system and in accuracy with those of modern times, and they were also superior to those of his successors for fully half a century. As the time element is of the first consequence in the derivation of stellar proper motions, Bessel, who in 1819 made the first reduction of the Bradley observations, was fully justified in giving his work the title "Fundamenta Astronomiæ." Excellent as Bessel's work was,

the rapid progress of astronomy in the next half-century led to a more accurate knowledge of the fundamental astronomical constants and to more refined methods in the reduction of meridian observations, and it also became evident that some of his assumptions respecting Bradley's instrument were erroneous. A new reduction was therefore highly desirable and this was undertaken by Dr. Auwers in 1866. He brought all his skill and special knowledge into play and spared no pains to insure the utmost accuracy in his work. The result of the ten years' labor it involved has been well called a "masterpiece and a model." The Auwers-Bradley catalogue at once became the starting point for all discussions of proper motions—a position it will probably hold for all time.

His fundamental system of star places, the Auwers-Bradley catalogue, and his other work in related fields, will form Auwer's most enduring monuments, but they are far from comprising the full measure of his activities. Thus, he was chairman of the German Commission for the determination of the solar parallax from the transits of Venus in 1874 and in 1882. He took the leading part in preparing the observing programs, conducted in each year one of the expeditions sent out by the government, and personally directed the elaborate discussion of all the results—a truly monumental work which fills six large quarto volumes.

From 1878 to 1912 Auwers held the position of Secretary of the Section for Mathematics and Physics in the Royal Prussian Academy of Sciences (Berlin Academy) and his tactful conduct of the manifold duties of this office, together with his unselfish and tireless devotion to the interests of the academy were gratefully acknowledged by his colleagues at the meeting of June 25, 1912, when they celebrated his jubilee—the fiftieth anniversary of his graduation as doctor of philosophy.

He founded the bureau of the "History of the Sidereal Heavens" (Geschichte des Fixsternhimmels) whose object it is to collect all of the meridian observations of stars since Bradley's time and to combine them into a single systematic catalogue. He was a member of the commission charged with the organization of the Astrophysical Observatory at Potsdam, and assisted in the supervision of its construction and of its management in its early years. He was also the first president of the International Association of Academies.

Auwers's commanding position in his chosen science was fully recognized in his own country and throughout the world. His own government gave him the title Wirklicher Geheimer Ober-Regierungsrat, and at the time of his death he was Kanzler des Ordens pour le mérite für Wissenschaft und Künste. For more than twenty years before his death he had been a member of the seven leading National Academies of Science in Europe and America, a distinction in which but two other astronomers of his generation shared—Newcomb and Schiaparelli. In 1888, he was awarded the gold medal of the Royal Astronomical Society of London, in 1891, the Watson gold medal of our National Academy, and in 1899, the Bruce gold medal of the Astronomical Society of the Pacific. His death marks the passing of one of whom Newcomb wrote, nearly twenty years ago, "To-day, Auwers stands at the head of German astronomy. In him is seen the highest type of the scientific investigator of our time." These sentences well express the judgment of all astronomers at the present day.

R. G. Aitken

March 22, 1915

SCIENTIFIC NOTES AND NEWS

A meeting to commemorate the life and scientific work of the late Charles Sedgwick Minot was held on March 17, in the hall of the Boston Society of Natural History. As president of the society since 1897, Dr. Minot had taken great interest in its welfare and growth, and it was due in large part to his efforts that the society has undertaken the study and exhibition of the natural history of New England as its special field. At the meeting addresses were made by Dr. Henry H. Donaldson, of the Wistar Institute of Anatomy and Biology, and Dr. Charles W. Eliot, of Cambridge. Dr. Donaldson especially dwelt upon Minot's early interest in natural history and his scientific career. Dr.

Eliot brought out particularly his great accomplishments for Harvard University in the development of teaching and research in the medical school, and emphasized the remarkable personal qualities that fitted him for this work.

There was printed in Science last week a list of the fifteen candidates selected by the council for election into the Royal Society. The *British Medical Journal* gives information in regard to their positions and work which we reproduce. The men are: Dr. F. W. Andrewes, professor of pathology in the University of London and pathologist to St. Bartholomew's Hospital; Dr. A. W. Conway, professor of mathematical physics, University College, Dublin; Mr. L. Doncaster, superintendent of the University Museum of Zoology, Cambridge, well known for his researches into the Mendelian hypothesis; Mr. J. Evershed, director of the Solar Physics Observatory, Kodaikanal, India; Dr. Walter Morley Fletcher, secretary of the Medical Research Committee established under the Insurance Act; Mr. A. G. Green, professor of tinctorial chemistry, University of Leeds; Mr. H. H. Hayden, director of the Geological Survey of India; Dr. James Mackenzie, whose researches into the action of the heart in health and disease have made his name well known to the profession; Dr. J. C. McLennan, professor of physics, University of Toronto; Dr. A. T. Masterman, fisheries inspector; Dr. G. T. Morgan, professor of chemistry in the Royal College of Science, Dublin; Dr. C. S. Myers, director of the laboratory of experimental psychology, Cambridge; Mr. G. C. Simpson, imperial meteorologist, India; Mr. A. A. Campbell Swinton, one of the early workers with the X-rays and wireless telegraphy, and Mr. A. G. Tansley, lecturer on botany, University of Cambridge.

The dedicatory exercises of the new buildings of the Washington University Medical School will be held April 29 and 30. According to the *Journal* of the American Medical Association the exercises include, in addition to the various entertainments, addresses by the dean of the medical school, Dr. Eugene Lindsay Opie; by Dr. William Henry Welch, Baltimore, of Johns Hopkins University; President Abbott Lawrence Lowell, of Harvard University; President Henry Smith Pritchett, of the Carnegie Foundation for the Advancement of Teaching; President George Edgar Vincent, of the University of Minnesota; Drs. William Townsend Porter, Robert James Perry, Fred Towsley Murphy and George Dock, of Washington University, Abraham Flexner, assistant secretary of the general education board, and Major-General William Crawford Gorgas, surgeon-general U. S. Army. On April 28, exercises in commemoration of Dr. William Beaumont will be held, including the presentation of the manuscripts and letters of William Beaumont to Washington University Medical School, the acceptance of the gift by the chancellor of the university, and addresses on "William Beaumont as a Practitioner," by Dr. Frank J. Lutz, and "William Beaumont as an Investigator," by Dr. Joseph Erlanger.

According to *Nature* the Imperial Society of Naturalists of Moscow has removed the names of Professor Haeckel and Professor Ostwald from the list of members on account of their having signed the address, "To Civilized Nations."

Professor Victor Hensen, the well-known physiologist of Kiel, has celebrated his eightieth birthday.

Dr. John R. Murlin has been granted leave of absence from Cornell University Medical College, New York City, to accept a temporary appointment as biochemist at the Pellagra Hospital of the Public Health Service at Spartanburg, S. C.

Professor Benj. L. Miller, head of the department of geology of Lehigh University, has left for an extended trip through South and Central America in company with Dr. Joseph T. Singewald, Jr., associate in economic geology in Johns Hopkins University. Most of their time will be spent in the various mining districts of the countries visited, but they will make some other geologic investigations, especially in the Andes, where

they hope to study some of the highest volcanic peaks.

Dr. Philip J. Castleman, who has held the position of assistant director of the bacteriological laboratory of the Boston Board of Health, has been appointed director of the laboratory. He succeeds Dr. James J. Scanlan, whose death occurred recently.

Cooperative agreements have been effected by the Oregon Agricultural College and the Drainage Division of the United States Department of Agriculture, whereby extensive drainage operations will be carried on in Oregon during the coming year. Mr. Guy N. Hart, of the federal department, and Professor W. L. Powers, irrigation and drainage specialist of the college, expect to begin operation about April 15.

Dr. Ernest Anderson, professor of general and physical chemistry at the Massachusetts Agricultural College, has had under consideration the position as head of the department of science of the Margaret Morrison School of the Carnegie Institute, Pittsburgh, Pennsylvania, but has decided to remain in Massachusetts.

Franklin C. Gurley, a graduate assistant in chemistry at the Massachusetts Agricultural College, has accepted a position as chemist with the Benzol Products Company of Philadelphia.

The third annual Faculty Research Lecture at the University of California was given by Professor Armin O. Leuschner on March 23 on "Recent Progress in the Study of Motions of Bodies of the Solar System."

The annual meeting of the Syracuse University Chapter of the Alpha Omega Alpha Fraternity was held March 18. A banquet was served at which the guest of honor was Dr. Walter B. Cannon, of Harvard University, who delivered an address on "The Psychology of Martial Emotions."

At a general meeting of the New York Academy of Sciences and its affiliated societies on March 22 at the American Museum of Natural History there was a social hour, with refreshments, beginning at 9:30 p.m., preceded, at 8:15 p.m., by a lecture under the auspices of the Section of Anthropology and Psychology, entitled, "Incidence of the Effect of Moderate Doses of Alcohol on the Nervous System," by Professor Raymond Dodge, of Wesleyan University.

Dr. Augustus H. Gill, professor of technical analysis at the Massachusetts Institute of Technology, addressed the Detroit Engineering Society on March 19 on "Lubricating Oils: Essentials and Characteristics."

Dr. George W. Crile repeated his lecture on "Education and War" in the Amasa Stone Memorial Chapel, Western Reserve University, on the evening of March 31. Dr. Crile consented to repeat his lecture by reason of the great numbers who were unable to gain admission at its first delivery.

Mr. F. H. Newell, head of the United States Reclamation Service, addressed the students of the College of Engineering, University of Illinois, on March 24, on the subject of "The Engineering and Economic Results of Reclamation Work."

Professor Chas. Baskerville lectured before the Princeton Chemical Society on February 25, on "Physical Chemistry and Anesthesia."

Professor H. P. Talbot, of the Massachusetts Institute of Technology, lectured on "The Noble Gases," on March 25, before the Phi Lambda Upsilon of Columbia University.

The fifth annual May lecture of the Institute of Metals, London, will be given on May 12 by Sir J. J. Thomson.

A special lecture on the septic infection of wounds was delivered before the Royal Society of Medicine, London, on March 30, by Sir Almroth Wright, who dealt with the results of his investigations and research with the expeditionary force.

A state biological survey, suggested by the Ohio Academy of Science, is being undertaken with a state appropriation of $2,500, a number of the colleges of the state cooperating. The preparation of duplicate material and separate collections for the colleges and other educational institutions is the primary feature of the work.

Dr. Sidney Coupland has been appointed Harveian orator of the Royal College of Physicians, London, for 1915; Dr. J. Michell Clarke Bradshaw lecturer for 1915, and Dr. Samson G. Moore Milroy lecturer for 1916.

Lady Huggins, widow of Sir William Huggins, the distinguished astronomer, and known for her scientific work, died at her home in London, on March 25. Lady Huggins was born in Dublin and married Sir William Huggins in 1875. She was joint author with him of many scientific papers, and of an Atlas of Representative Stellar Spectra. She was the author of a monograph on the Astrolabe; of articles in the Encyclopædia Britannica, and of papers in astronomical and archeological journals.

Professor Neuhauss, of Berlin, noted for his anthropologic investigations and his work in the field of color photography, has died at the age of fifty-nine years from diphtheria, contracted while engaged in military hospital work.

Dr. Clon Stéphanos, director of the Anthropological Museum of the University of Athens, died on January 24, at the age of sixty years.

A correspondent informs us that the following German zoologists have been killed in the war: Professor Stanislaus von Prowasek, head of the zoological department of the Institute for Tropic Diseases, Hamburg; Dr. W. Meyer, assistant in the same institute; Dr. W. Mulsow, assistant in the protozoological department of the Institute for Infectious Diseases, Berlin; Dr. G. Kantsch, docent for zoology, Kiel; Dr. v. Steudell, Edinger Institut, Frankfurt; Dr. v. Müller, assistant in the Zoological Institute, Kiel; Dr. v. Greinz, assistant in the Zoological Institute, Königsberg. The following have been wounded, but have in some cases recovered: Professor O. zur Strassen, professor of zoology, Frankfurt; Professor L. Rhumbler, professor of zoology, Forest School, Minden; Dr. W. Reichensperger, docent for zoology, Bonn; Dr. C. Thienemann, docent in Münster.

The American Ethnological Society has addressed the following reply to the French universities, which have addressed the scientific bodies of neutral countries, setting forth their view of the causes of the war:

The American Ethnological Society acknowledges the receipt of the communication of the French universities to the universities of the neutral countries, dated November 3, 1914, and takes the opportunity to express its sincere sympathy for the sufferings that the present war is inflicting upon France and other European countries.

The society appreciates and respects the sentiments that have dictated the statement transmitted to it, but believes, regardless of the feelings of the individual members, that it behooves it to listen with the same respect that it gladly grants to you to the statements emanating from other nations. The society, being located in a neutral country, does not share the passions engendered by the patriotic feelings of the citizens of all the contending nations. It is conscious, however, that if the United States of America should find themselves involved in a similar struggle, our members might feel the same intense desire to convince the world of the righteousness of their cause as impels at present French, German and British scholars.

At present, on account of the remoteness from warlike passions, the society is mindful that the time will come (and we devoutly hope it may come soon) when the universities and scientists of the whole world may work together again for the true ideals of mankind, that know no national boundaries, when respect for the individuality of each nation may again take the place of harsh recrimination, when the true spirit of cooperation that has characterized scientific work of the past century may reappear. When that moment arrives, the passionate expressions of an excited time will not and must not stand in the way of mutual understanding and of a renewal of old friendships.

The council of the Society of American Bacteriologists has decided to hold a special summer meeting in San Francisco, August 3, 4 and 5, 1915. The chairman of the local committee of arrangements is Dr. Wilfred H. Manwaring, Stanford University, California.

The Princeton University Observatory has received from Mr. Archibald D. Russell, of New York, a gift of the sum necessary for the carrying on for five years of its share of the work described in Professor Pickering's summary of the present needs of astronomical research (Science, January 15, 1915).

Through the efforts of Dr. Ralph Arnold, and other alumni of the department of geol-

ogy and mining, Stanford University has just added to its collections the working library and material of the late Professor Henry Hemphill, of Los Angeles. The collection contains between 8,000 and 9,000 specimens of shells and 150 volumes. The material is of very great importance in the study of the Tertiary geology of the Pacific coast, and especially of the geology of the petroleum deposits of California.

THE trustees of the Presbyterian Hospital, New York City, have taken an option to purchase the former American League baseball grounds, bounded by Broadway, Fort Washington avenue, 165th and 168th Streets. This site is owned by the New York Institute for the Education of the Blind, which has been holding it in the market at $2,000,000. Purchase of the site is made possible by the bequests of the late John S. Kennedy, by whose will the hospital receives about $2,500,000. It is understood that the College of Physicians and Surgeons, the medical school of Columbia University would be removed to the new site. Mr. Edward S. Harkness gave, in 1910, $1,500,000 toward an alliance between the hospital and the university.

UNIVERSITY AND EDUCATIONAL NEWS

BY the will of General Brayton Ives, of New York City, the largest part of his estate is bequeathed to Yale University for its general purposes. The daily papers estimate the value of the bequest at from $750,000 to $1,500,000.

MR. W. E. ALLEN, of Sheffield, has bequeathed about $750,000 to public purposes, including $25,000 and part of the residuary estate to the University of Sheffield for work in applied science.

ACCORDING to private information received from Mexico, the Carranza government has closed all educational and scientific institutions in Mexico, including not only the University, the Geological Institute, the Medical Institute and the National Museum, but also all normal schools, high schools and elementary schools under its control.

THE department of chemistry at Iowa State College, Ames, Iowa, is now installed in the new chemistry building which replaces the one destroyed by fire in March, 1913. The building is constructed entirely of brick, stone and concrete and is as near fireproof as possible. The initial cost was $200,000, and the building is 244 feet by 162 feet; three stories high, with a usable basement.

THREE Whiting fellowships in physics, each with an income of $600, for the college year 1915–16, have been filled at the University of California. Fellowships on this endowment fund are conferred for the purpose of furthering advanced study, either abroad or at an American university.

STUDENTS in the newly established forestry school at the University of California are to receive instruction in game conservation. They will be taught to recognize at sight the different species of game fish and animals and will be informed as to the economic value of each and the means by which they can be conserved. Dr. H. C. Bryant, in charge of the bureau of education, publicity and research recently established by the California Fish and Game Commission, will give the introductory lectures. He will be followed by N. B. Scofield, in charge of the department of commercial fisheries, and Dr. W. P. Taylor, curator of mammals in the University of California Museum of Vertebrate Zoology.

DR. ANDREW HUNTER, of the Cornell Medical School, has been appointed professor of pathological chemistry in the University of Toronto.

DR. R. TRAVERS SMITH has been appointed to the chair of materia medica, therapeutics and pharmacology in the school of surgery of the Royal College of Surgeons in Ireland.

DISCUSSION AND CORRESPONDENCE

EVIDENCE BEARING ON THE ORIGIN OF HUMAN TWINS FROM A SINGLE OVUM

ON the supposition that twins originate always from two ova, and that the chances are even as to whether an individual of a pair of twins is to be male or female, the ratio of like pairs to those whose members are of different sex may be worked out according to the laws of chance. The Mendelian ratio

under corresponding circumstances is 1:2:1; that is, there should be one pair of boys, to two mixed pairs, to one pair of girls. In other words, if the members of a pair of twins always developed from separate ova, we should expect to find twice as many pairs whose members differ in sex, as there are pairs of girls, or pairs of boys. I have been able to think of no factor which may reasonably be supposed to be acting in a constant direction to alter this ratio.

I have undertaken to compare with this hypothetical ratio the ratio found among births of twins in this country. My data number 3,334 twin births which occurred in the states of Connecticut, Maine and Vermont during the years 1899 to 1912. Of this number 1,118 are pairs of boys, 1,193 are boy and girl, and 1,023 are pairs of girls. This is almost a 1:1:1 ratio, showing the effect, however, of the predominance of male births. There is obviously a large excess of pairs similar in sex over what is to be expected on the supposition that twins originate in all cases from separate ova, an excess of more than 500 pairs of boys, and almost 500 pairs of girls.

This seems to point towards the conclusion that twins may originate from a single fertilized ovum. In the light of present knowledge this certainly is a possible explanation of the statistics. If the figures given will bear this interpretation, we may say that less than half (44.3 per cent.) of the twin births of similar sex, or less than one third (28.4 per cent.) of all twins, originate from one ovum, while slightly more than half (55.7 per cent.) of those of similar sex have developed simultaneously from two separate ova.

Margaret V. Cobb

Falls Church, Va.

NATURALIST'S DIRECTORY

To the Editor of Science: As you have given liberal space to criticize the book, you will doubtless be willing to give space in which I can explain the matter.

In the first place this book has not been issued for some eight years, and in getting out the new edition I decided that not a single name would be included unless I had a request that the name should be included from each party. If you find that there are a good many naturalists omitted from the directory, it was because they were too busy, or more likely too careless of such matters to take time to return the blanks which I sent them. Every naturalist of any consequence, and a great many collectors, received three notices each and none of the names were included in the book unless they replied.

Since getting out the work some of these noted scientists have taken time to write three or four criticisms of the book, while they would not take time before publication to even sign their names to the blanks I sent them. There are a few typographical errors in the book as there are bound to be in any work of this kind, and the transposition of two or three entries, to which you have taken great pains to call attention, was caused by the misplacement of one or two linotype slugs.

It is my intention to get out another edition of the Naturalist's Directory in a year from now, and I hope naturalists, generally, will be as free with their assistance in bringing the new edition up to date, as they have been in criticizing the edition just published.

S. E. Cassino

Salem, Mass.

SCIENTIFIC BOOKS

Die Variolation im achtzehnten Jahrhundert. Ein historischer Beitrag zur Immunitätsforschung. By Arnold C. Klebs. Giessen, A. Töpelmann. 1914. 8vo. Pp. 78.

Few physicians know that throughout the entire eighteenth century, and before Jenner's time, there was a vast wave of experimental research in the problem of preventive inoculation against disease, now almost forgotten. Starting in 1713, it passed into a period of twenty years' stagnation about 1727, with a revival in 1746 and a truly scientific phase during 1764–98. When a bibliography of some 600 titles, by the author of the above monograph, was shown to a highly educated physi-

cian, he said: "Yes, but all that is merely a fragment of the huge literature of vaccination!" not realizing that variolation and vaccination are distinct and separate episodes in medical history. Variolation is preventive inoculation against smallpox by means of virus taken from the human subject. In vaccination, the virus is supposed to be modified or attenuated by transmission through the body of the cow. The recent application of such terms as "vaccines" or "vaccinotherapy" to diseases other than smallpox, although now likely to remain current, is inexact and unscientific, since none of the non-Jennerian "vaccines" are passed through the cow.

Dr. Klebs, who has gone into this subject more extensively than any one else, has, in his memoir, amplified the admirable paper, read at the Johns Hopkins Hospital in 1912, by an examination of literature covering over 1,200 titles.[1] Only von Pirquet has appreciated the importance of this vast literature, which he has declared to be too overwhelming and distracting for investigation. The object of Klebs's memoir is to show the importance of "historical medicine" in the illumination or interpretation of present-day problems. For instance, the extensive experiments in inoculation of smallpox which Councilman, Brinkerhoff and Tyzzer made upon anthropoid apes at Manila, did not throw any such light upon the subject as the thousands of successful inoculations made upon man in the eighteenth century. Dr. Klebs regards variolation as a remarkable example of the value of folk intuitions in etiology and therapy. Many important advances in practical medicine have undoubtedly come from the non-medical, but these can hardly be said to have arisen from the great mass of the people, rather, on the primitive minds, *adscripti glebæ,* whose mental development was a little higher than the average. The usual process in evolution is that out of a vast number of people of primitive minds, *adscriptus glebæ,* whose mental processes are nearly all exactly alike, there arises occasionally one in whom a more specialized type of mind is born, through suffering or other experience. Then, as Emerson says, "all things are at stake." The interesting thing about variolation is that, like the primitive chipped flints all over the globe, or the ever-recurring *themata* of folk-lore, it seems to have arisen spontaneously among different savage or semi-civilized races. In this monograph it is shown that variolation has been practised from a remote period in China and India and among such African tribes as the Somalis, Ashantis and Wagandas. Cotton Mather is said to have first heard of the practise from his African slave, Onesimus. Baas's statement that inoculation is mentioned in the Atharva Veda is, however, unverifiable. In Germany and Russia, the custom of "buying the smallpox" was known from the seventeenth century on, variolation being produced by bringing the scabs, purchased in open market, or the pus in contact with the skin. This was probably a phase of the ancient superstition of the sympathetic transference of disease. In 1713, smallpox inoculation was brought to European attention from Oriental sources by Emanuel Timoni, who had his daughter inoculated in 1717. Lady Mary Montagu followed with the inoculation of her infant daughter in April, 1721, and, on June 26, 1721, Zabdiel Boylston of Boston, Mass., began his long series of inoculations in which, by 1752, he had 2,124 cases, with only 30 deaths, while, in 1743, Kirkpatrick, in South Carolina, had nearly 1,000 cases, with 8 deaths. At this time the *modus operandi* was incision, with sometimes a dietetic and depletory "preparation," usually blood-letting and purging. In 1760, Robert and Daniel Sutton were inoculating by puncture, discarding the depletory regimen for the more sensible strengthening of the patient by dietetic and hygienic means, and had some 30,000 cases, with about 4 per cent. mortality. Attenuation of the virus was attempted by passing it through several human subjects (Kirkpatrick's arm-to-arm method), by using very small quantities, by dilution with water, calomel, etc., or by choosing the virus at the crude or unripe stage. The author

[1] A remarkably complete bibliography of variolation, down to Jenner's time, and of vaccination (1798–1861) was printed (not published) by Dr. Ludwig Pfeiffer (of "Pestilentia in nummis") about 1863.

cites experiments which would stand comparison with those carried out in modern laboratories, especially those tabulated from William Watson's series of 1768, in which it is seen that Jenner did not initiate experimental research upon the subject but rather devised or followed lines already established before him. The most scientific worker in the field was Angelo Gatti of Pisa, who obtained permission to inoculate in Paris by the rational method of puncture and preparation in 1769. Gatti maintained that smallpox is always caused by the introduction into the body of a foreign body, which is in the nature of a specific virus in that it reproduces itself and multiplies, the disease being communicated by contact, inhalation or ingestion. He waxed furious against the senseless practise of weakening the patient by bleeding and purging, adopted Sutton's open-air and hydropathic régime, and offered prizes in real money for any authenticated case of reinfection after inoculation. Such cases he regarded as eruptions from a mixed infection of other exanthems, such as scarlatina or measles, which he also thought capable of transference by inoculation. The main difficulty with variolation was that each inoculated person was a possible "carrier" of the disease, and this occasioned Gatti and his associates considerable trouble in Paris. In the meantime, Tronchin, Tissot, Mead and other eminent physicians were influential in spreading the practise, which became a common preventive measure in America during the Revolutionary War. In 1768, Thomas Dimsdale was invited to St. Petersburg to inoculate Catherine the Great and her son, receiving for his trouble a barony, $50,000 down, an annuity of $2,500, $10,000 for his expenses and handsome gifts of diamonds and furs. Jenner's experiments of 1796–8 soon swept variolation from the field, for the sufficient reason that there was little mortality and no possibility of transference of the disease by the vaccinated person. Variolation was declared a felony by Act of Parliament in 1840.

Dr. Klebs's memoir is well worthy of perusal by all who are interested in the history of preventive inoculation. Its permanent value is that it obviates the boresome necessity of investigating the huge literature of variolation, covering even the secular memoirs of eighteenth century celebrities. Its engaging style makes it eminently readable, revealing everywhere the spirit of its genial author.

F. H. Garrison

Army Medical Museum

A Primer on Alternating Currents. By W. G. Rhodes. Longmans, Green & Company. 1912. Pp. 145.

Although this book, according to the author, is primarily intended for students preparing for the alternating current part of the ordinary grade examination in electrical engineering of the city and guilds of London, it should be useful to those desiring a very brief elementary course on alternating currents and alternating current machinery. The book is primarily adapted to the use of evening classes in technical schools, and is written in such a way that no knowledge of mathematics is required beyond the elements of algebra. In order to avoid the necessity for the students in these classes to possess a multiplicity of books, such simple mathematical relations as are necessary for the development of the subject are proved in the first chapter of the book. For a similar reason, some useful constants and a short table of logarithms are given.

The early chapters of the book are devoted to developing the elementary principles of magnetism, induction and alternating currents. Alternating currents in circuits containing inductance and capacity are briefly considered. The rest of the book deals with transformers, synchronous motors, induction motors and rotary converters. In this part of the book use is made of simple vector diagrams. At the end of the book a few pages are given to the elementary principles underlying transmission of electrical energy and to simple power measurements. The usefulness of the book is increased by the addition of a number of examples with answers which are given at the end of each chapter.

This little book is well adapted for the purpose for which it is intended. One should expect to find in its 145 pages more than a most brief and elementary treatment of the

broad subject of alternating current and alternating current machinery.

RALPH R. LAWRENCE

Alternating Current Machinery. By BARR and ARCHIBALD. The Macmillan Company. 496 pages and 16 plates.

The title of this book is too broad and somewhat misleading as only certain types of alternating current machinery are considered, namely: the transformer, the alternator, and the rotary converter. No mention is made of induction machines or of the synchronous motor. The first chapters are devoted to complex wave forms and their analysis and to the properties of insulating materials used in alternating current machinery. The insulation of transformers and generators is also briefly considered. The remaining chapters deal with the theory and the design of the transformer, the alternator and the rotary converter. Three chapters are devoted to the transformer. Two of these are given up to the consideration of the fundamental principles, construction and vector diagrams, while the third is confined entirely to design. Some examples of different designs are included. Nine of the remaining twelve chapters deal with the alternator. The mechanical construction of alternators, different types of armature windings, harmonics caused by teeth, and the magnetic circuit are discussed in the first of these chapters. Several chapters are devoted to the discussion of armature reaction, voltage regulation and regulation tests. The effect of a sudden short circuit is also considered. The discussion of the losses, efficiency and heating of alternators is also given considerable space. One chapter is devoted to the parallel operation of alternators. The last chapter on alternators, a chapter of about forty pages, deals only with design. Several examples of design are given. The remaining three chapters are confined to the rotary converter and take up the transformation voltage ratio, armature reaction, armature heating and output. Voltage regulation, losses and efficiency, methods of starting and parallel working are discussed. The last chapter of the book deals entirely with the design of converters, and as in the other chapters on design, examples of the design of several converters are given. It is unfortunate that the author has used clockwise and anti-clockwise directions of rotation indiscriminately on the vector diagrams to indicate a positive direction of rotation. Although an arrow is added to each vector diagram to indicate which direction of rotation has been adopted, the lack of a definite convention in this connection is apt to lead to confusion. The book is in general well arranged and should be a valuable one alike to the student and the engineer.

RALPH R. LAWRENCE

SCIENTIFIC JOURNALS AND ARTICLES

THE opening (January) number of volume 16 of the *Transactions of the American Mathematical Society* contains the following papers:

G. M. Green: "On the theory of curved surfaces, and canonical systems in projective differential geometry."

H. S. White: "The multitude of triad systems on 31 letters."

G. A. Miller: "The Φ-subgroup of a group."

R. L. Moore: "On a set of postulates which suffice to define a number-plane."

W. C. Graustein: "The equivalence of complex points, planes, lines with respect to real motions and certain other groups of real transformations."

J. E. Rowe: "Invariants of the rational plane quintic curve and of any rational curve of odd order."

M. G. Gaba: "A set of postulates for general projective geometry."

Virgil Snyder and F. R. Sharpe: "Certain quartic surfaces belonging to infinite discontinuous cremonian groups."

Joseph Slepian: "The functions of a complex variable defined by an ordinary differential equation of the first order and the first degree."

Arthur Ranum: "On the differential geometry of ruled surfaces in 4-space and cyclic surfaces in 3-space."

THE February number (Vol. 21, No. 5) of the *Bulletin of the American Mathematical Society* contains: Report of the eighth regular meeting of the Southwestern section, by O.

D. Kellogg; "Note on the potential and the antipotential group of a given group," by G. A. Miller; "The equation of Picard-Fuchs for an algebraic surface with arbitrary singularities," by S. Lefschetz; Review of Manning's Geometry of Four Dimensions, by J. L. Coolidge; "Shorter Notices"; Schröder's Entwicklung des mathematischen Unterrichts an den höheren Mädchenschulen Deutschlands, by E. B. Cowley; de Montessus and d'Adhémar's Calcul numérique and Dickson's Elementary Theory of Equations, by R. D. Carmichael; Smith's Teaching of Geometry and Smith and Mikami's History of Japanese Mathematics, by J. V. McKelvey; Study's Die realistische Weltansicht und die Lehre vom Raume and Jordan and Fiedler's Contribution à l'Etude des Courbes convexes fermées et de certaines Courbes qui s'y rattachent, by Arnold Emch; Mrs. Gifford's Natural Sines to Every Second of Arc, and Eight Places of Decimals, by D. E. Smith; Cobb's Applied Mathematics, by E. B. Lytle; von Sanden's Praktische Analysis and Hjelmslev's Darstellende Geometrie, by Virgil Snyder; "Notes"; and "New Publications."

THE March number of the *Bulletin* contains: Report of the twenty-first annual meeting of the society, by F. N. Cole; Report of the winter meeting of the society at Chicago, by H. E. Slaught; "The structure of the ether," by Harry Bateman; "Shorter Notices": Killing and Hovestadt's Handbuch des mathematischen Unterrichts, Band II, by D. D. Leib; Cahen's Théorie des Nombres, Tome premier, and Darboux's Théorie générale des Surfaces, première Partie, by T. H. Gronwall; "Notes"; and "New Publications."

SPECIAL ARTICLES

INTERPOLATION AS A MEANS OF APPROXIMATION TO THE GAMMA FUNCTION FOR HIGH VALUES OF n [1]

VARIOUS approximations to the value of $\Gamma(n)$ when n is large have been suggested by different workers and are in every-day use. In actual statistical practise the one which has appealed to the writer as most satisfactory, having regard to ease of calculation and degree of accuracy of result, is that of Forsyth,[2] which is

$$\Gamma(n+1) = \sqrt{2\pi}\left(\frac{\sqrt{n^2+n+\frac{1}{6}}}{e}\right)^{n-\frac{1}{2}}.$$

This is in error (in defect) in the proportion of $1/240n^3$.

It lately occurred to me that possibly a further saving of labor in computation, without loss of accuracy, could be made by interpolating in a table of log $\underline{|n}$ to get log $\Gamma(n)$. Tables of the sums of the logarithms of the natural numbers have recently been made readily available to statistical workers from different sources.[3] Such tables all proceed, of course, by integral steps of the argument n.

The question then is to determine what the order of magnitude of the error will be if one interpolates from such a table proceeding by integral steps, in order to determine $\Gamma(n)$. The relation

$$\Gamma(n+1) = \underline{|n} \qquad \text{(i)}$$

is exact when n is an integer. How great is the inequality when n is not integral but fairly large?

To test this matter I asked Mr. John Rice Miner, the staff computer of the laboratory, to carry through the computations for a short series of representative values of n. This he has done, with the results set forth in Table I., for which I am greatly obliged. It should be said that in all the computations seven-place logarithms only have been used. The first column, headed "exact value," gives the result obtained by using the value of log $\Gamma(x)$ for $x = 1.123$ from Legendre's tables, and then summing the logarithms up to $n-1$ for each desired value. This is the usual process, depending on the relation

[1] Papers from the Biological Laboratory of the Maine Agricultural Experiment Station, No. 80.

[2] Forsyth, Brit. Assoc. Rept. for 1883, p. 47.

[3] *Cf.* Pearl and McPheters, *Amer. Nat.*, Vol. XLV., 1911, p. 756. More recently a longer table of sums of logarithms has been published in Pearson's "Tables for Statisticians and Biometricians," Cambridge, 1914.

$$\Gamma(n+1) = n\,\Gamma(n) = n(n-1)(n-2) \quad . \; . \; . \; (n-r)\,\Gamma(n-r). \qquad \text{(ii)}$$

It becomes an exceedingly tedious operation when n has a value of over, say, 20. In calling this the "exact" value in the table the intention is merely to convey the idea that the only approximation involved is that incident upon the use of 7-place logarithms, the process *per se* being an exact one. The fourth and fifth columns of the table give the results obtained by using the values of log $\underline{|n}$, their first second and third differences, in the usual advancing difference interpolation formula

$$u_{x+n} = u_x + n\,\Delta\,u_x + {}_nC_2\,\Delta^2\,u_x + {}_nC_3\,\Delta^3\,u_x \cdots. \qquad \text{(iii)}$$

TABLE I

Values of log Γ (n) by Different Methods

n	Exact Value	Forsyth's Approximation	Interpolation Using Δ^2	Interpolation Using Δ^3
5.123	1.4613860	1.4613679	1.4619138	1.4615009
15.123	11.0834931	11.0834916	11.0835559	11.0834985
25.123	23.9637108	23.9637096	23.9637336	23.9637119
35.123	38.6594135	38.6594126	38.6594251	38.6594138
75.133	107.7498704	107.7498692	107.7498727	107.7492870

From this table it is evident that the interpolation method, when third differences are used, gives values slightly better than those by Forsyth's method when $n \gtreqless 25$. For $n = 75$ or more the interpolation method using only second differences gives an approximation sufficiently close for all practical statistical purposes. As to the labor involved, there is no great amount of choice between Forsyth's and the interpolation method, but on the whole there appears to be a distinct, if small, advantage in favor of the interpolation.

RAYMOND PEARL

THE GEOLOGICAL SOCIETY OF AMERICA

THE twenty-seventh annual meeting of the Geological Society of America was held at the Academy of Natural Sciences, Philadelphia, December 29–31, 1914, under the presidency of Dr. George F. Becker, of the United States Geological Survey, Washington, D. C. On account of Dr. Becker's enforced absence through illness, the sessions were presided over by Vice-presidents Waldemar Lindgren and Horace B. Patton. In attendance there were registered 117 Fellows of the Society and the number of students and others, including members of the American Association for the Advancement of Science who were present at the sessions, swelled the attendance to more than 200, making this one of the most largely attended meetings in the history of the society.

At the first general session of the society Dr. Samuel G. Dixon, president of the Academy of Natural Sciences, welcomed the visiting geologists and paleontologists, making them feel very much at home as the guests of the historic academy.

The report of the council, as submitted in print, showed that the present enrollment of the society is 363, aside from the 19 new fellows elected at the meeting but who had not yet qualified. During the year 1914 the society lost five fellows by death: Alfred E. Barlow, Albert S. Bickmore, Horace C. Hovey, A. B. Wilmott and Newton H. Winchell; and three correspondents: H. Rosenbusch, Eduard Suess and Th. Tschernyschew. The treasurer's report showed that the society was in a flourishing condition financially and the editor's report indicated an unusual activity in publication during the past year.

The papers presented in the three general sessions of the society were as follows:

Relation of Bacteria to Deposition of Calcium Carbonate: KARL F. KELLERMAN.

At the suggestion of Dr. T. Wayland Vaughan, bacterial studies of water and bottom mud from the Great Salt Lake, and sea water and bottom deposits from the vicinity of Florida and the Bahamas were undertaken in the hope of supplementing the work of Vaughan,[1] of Drew[2] and of Dole[3] in regard to the probable agencies concerned in the precipitation of calcium carbonate and the formation of oolites.

It has been possible to form calcium carbonate by the action of bacteria on various soluble salts of calcium both in natural waters and in synthetic mixtures. The most important natural precipita-

[1] T. Wayland Vaughan, *Bull. Geol. Soc. Am.*, Vol. 25, No. 1, p. 59, March, 1914. Also Publication No. 182, Carnegie Inst. of Washington, pp. 49–67.

[2] G. H. Drew, Publication No. 182, Carnegie Inst. of Washington, pp. 49–67.

[3] R. B. Dole, Publication No. 182, Carnegie Inst. of Washington, pp. 69–78.

tion is probably the transformation of calcium carbonate by the combined action of ammonia, produced by bacteria either by the denitrification of nitrates or by the fermentation of protein, together with carbon dioxide, produced either by the respiration of large organisms or the fermentation of carbohydrates by bacteria. Both ordinary crystals of calcium carbonate and oolites may be produced by the growth of mixed cultures of bacteria, either in salt or fresh water. The zonal structure of the oolites of bacterial origin and of those found in nature in oolitic deposits appears to be exactly the same; undoubtedly this shows the similarity of the processes of their origin.

Coral Reefs and Reef Corals of the Southeastern United States, Their Geologic History and Their Significance: Thomas Wayland Vaughan.

After briefly alluding to some of the more recent publications on coral reefs, the author stated what in his opinion were the necessary lines of investigation in order to understand the ecologic factors influencing coral reef development, the constructional rôle of corals and other agents, and the series of geologic events which preceded any particular coral reef development. The geologic history of the extensive coral reefs of the southeastern United States and nearby West Indian islands, which have been the subject of investigation for a number of years, was outlined and the bearing they have on the theory of coral reef formation was indicated.

The author stated his conclusions regarding the Florida coral reefs as follows: (1) Corals have played a subordinate part, usually a negligible part, in the building of the Floridian plateau; (2) every conspicuous development of coral reefs or reef corals took place during subsidence; (3) in every instance the coral reefs or reef corals have developed on platform basements which owe their origin to geologic agencies other than those dependent on the presence of corals.

The older Tertiary reefs and reef corals of St. Bartholomew, Antigua and Anguilla all grew on subsiding basements. The relatively small proportion of the contribution by corals to calcareous sediments in Florida, the Bahamas and the West Indies was shown.

It was shown that the Floridian plateau was similar in configuration to the Mosquito Bank off Nicaragua, to Campeche Bank off Yucatan and to Georges Bank off Massachusetts; the east side of the Floridian plateau is similar to the continental shelf off Cape Hatteras. The platform which supports the reef along the east coast of Florida extends beyond the reef limits northward of Fowey Rock. The reef platform of the Great Barrier Reef of Australia is similar to the continental shelf of eastern North and Central America, and it continues south of the reef limits. Rosalind Bank, Caribbean Sea, was compared with Rangiroa, Paumotus, which is similar in essential features. The complex history of the coral reef foundations in Florida, Antigua, St. Martin, Anguilla and Bermuda was described, and it was stated that the formation of the platforms could not be referred solely to Pleistocene time.

Attention was directed to the facts that around the Island of Saba, in which volcanic activity has so recently ceased that the crater is still preserved, there was scarcely any platform at all; that in the case of the young but slightly older volcanic island of St. Kitts, the platform was narrow, while the geologically much older islands standing above the Antigua-Barbuda bank, the St. Martin plateau, and the Virgin Bank, rise above platforms which are miles across and have an area many times greater than that of the present land surfaces. Width of platform is therefore indicative not of the amount of submergence, but of the stages attained by planation processes.

The conclusions were summarized as follows:

1. Critical investigations of corals as constructional geologic agents are bringing constantly increasing proof that they are not so important as was long believed, and that many of the phenomena formerly attributed to them must be accounted for by other agencies. Here it should be emphasized that the ecology of probably no other group of marine organisms is known nearly so thoroughly as that of corals.

2. All known modern off-shore reefs which have been investigated grow on platforms which have been submerged in recent geologic time.

3. No evidence has as yet been presented to show that any barrier reef began to form as a fringing reef on a sloping shore and was converted into a barrier by subsidence; but it is clear that many, if not all barrier reefs stand on marginal platforms which already existed previous to recent submergence and the formation of the modern reefs.

4. Study of the geologic history of coral reef platforms has established that there were platforms in early Tertiary time on the site of many of the present-day platforms, and evidence has not as yet been adduced to prove long-continued, uninterrupted subsidence in any coral reef area. There have been many oscillations of sea level and recent submergence is probably complicated in many

areas by differential crustal movement concomitant with increase in volume of oceanic water through deglaciation.

5. The width of a submerged platform bordering a land area is indicative not of the amount of submergence, but of the stage attained by planation processes. Other conditions being similar, the longer the period of activity of such processes the wider will be the platform.

6. The principal value of the coral reef investigation to geology consists not so much in what has been found out about corals as in the study of a complex of geologic phenomena, among which coral reefs are only a conspicuous incident.

Causes Producing Scratched, Impressed, Fractured and Recemented Pebbles in Ancient Conglomerates: JOHN M. CLARKE.

The Devonian conglomerate lying beneath the fish-beds of Migonasha, P. Q., is a characteristic "Nagelfluh" filled with scratched, fractured and deeply impressed pebbles. Specimens exhibited indicate that the explanation of the phenomena of impression by solution, as suggested by Sorby, Heim, Kayser and others, is inadequate and that the effects described are in large part actually due to forcible contact resulting from internal friction. Some of the pebbles show unqualified evidence of glacial scratching and the entire mass is regarded as an outwash from glacial moraine.

Revision of Pre-Cambrian Classification in Ontario: WILLET G. MILLER AND CYRIL W. KNIGHT.

During the past decade the authors have been engaged in detailed work on pre-Cambrian areas in various parts of the Province of Ontario. The results of this work, and that of other investigators, have made apparent the necessity for revising the age classification of the pre-Cambrian rocks, particularly in the use of the terms Huronian, Laurentian and others. The following classification and nomenclature have therefore been adopted by the Ontario Bureau of Mines.

KEWEENAWAN.

Unconformity.

ANIMIKEAN.

Under this heading the authors place not only the rocks that have heretofore been called Animikie, but the so-called Huronian rocks of the "classic" Lake Huron area, and the Cobalt and Ramsay Lake series. Minor unconformities occur within the Animikean.

Great Unconformity.

(ALGOMAN GRANITE AND GNEISS.)

Laurentian of some authors, and the Lorrain granite of Cobalt, and the Killarney granite of Lake Huron, etc.

Igneous Contact.

TIMISKAMIAN.

In this group the authors place sedimentary rocks of various localities that heretofore have been called Huronian, and the Sudbury series of Coleman.

Great Unconformity.

There is no evidence that this unconformity is of lesser magnitude than that beneath the Animikean.

(LAURENTIAN GRANITE AND GNEISS.)

Igneous Contact.

LOGANIAN.

Grenville (*Sedimentary*), Keewatin (*Igneous*).

The authors have found the Keewatin to occur in considerable volume in S. E. Ontario and have determined the relations of the Grenville to it.

Investigations by the junior author during 1914 have shown that certain rocks of the "classic" Huronian area of Lake Huron, the "Thessalon greenstones," that heretofore have been placed with the Keewatin, are of much later age, being in intrusive contact with the Animikean, as defined in the above table.

North American Continent in Upper Devonic Time: AMADEUS W. GRABAU.

The history of North America in the Upper Devonic has been worked out in some detail, on the basis of physical stratigraphy combined with paleontology.

At the opening of the Upper Devonic, marine waters were much restricted in North America, the greater part of the United States being exposed to active erosion of the previously deposited Hamilton or earlier formations, as indicated by disconformities. The Tully-Genesee sea was restricted to central New York, but extended northward over Canada. Appalachia, Atlantica (the Old Red Continent) and Mississippia were the chief continents. The evidence pointing to the gradual southward transgression of the sea over the eroded lands is clear. Three open marine water bodies existed throughout Upper Devonic time, each with its Urals, (2) the western or North Pacific, extending from central New York across Ellsmere land to the Urals, (2) the western or North Pacific extending across part of Alaska, (3) the eastern or Atlantic. The latter entered the interior by way of a narrow strait between Appalachia and Atlantica, permitting the periodic invasion of the Atlantic or Tropidoleptus fauna. There may have been a fourth South Pacific water body extending into Nevada, but this is less certain. Three principal river systems are recognized in the lowland of Mississippia. These have furnished the black mud for the black shales which were deposited in embayments of di-

minished salinity. The eastern or Genesee beds are restricted to New York and the states just south. The base of the black shale of Ohio, Michigan and Canada is younger than Genesee, as shown by stratigraphic and paleontologic evidence. The great fish fauna of these shales is shown by its occurrence and distribution to be primarily the fauna of these sluggish rivers projected at intervals into the brackish water of the embayments. The land flora of Mississippia is also preserved in these shales. The rivers of Appalachia and Atlantica also had their fish fauna, but these were of different types, their smaller size adapting them to these torrential streams. With them occurred the survivors of the Eurypterids, which also inhabited the rivers of the Paleozoic lands. The flora of Appalachia and Atlantica is likewise largely distinct from that of Mississippia. The deposits made by these rivers were partly preserved as sandy deltas and alluvial fans.

"Symposium on the Passage from the Jurassic to the Cretaceous."

(1) *The Morrison; An Initial Cretaceous Formation:* Willis T. Lee.

(2) *Origin and Distribution of the Morrison:* Charles C. Mook.

(3) *Sauropoda and Stegosauria of the Morrison Compared with those of South America, England and Eastern Africa:* R. S. Lull.

(4) *The Paleobotanic Evidence:* E. W. Berry.

(5) *The Invertebrate Fauna of the Morrison:* T. W. Stanton.

Present Condition of the Volcanoes of Southern Italy: H. S. Washington and A. L. Day.

A brief description of the general condition and state of activity at Vesuvius, Etna, Vulcano and Stromboli, as observed during the summer of 1914.

Recent Eruptions of Lassen Peak, California: J. S. Diller.

Lassen Peak, in northeastern California, at the southern end of the Cascade Range, has long been considered an extinct volcano, but has recently shown signs of rejuvenescence. The first of the recent outbreaks occurred at 5 P.M., May 30, 1914, and since then many eruptions have occurred. The nature of this remarkable phenomenon was illustrated and discussed.

Physiographic Study of the Cretaceous-Eocene Period in the Rocky Mountain Front and Great Plain Provinces: George H. Ashley.

The study of the rocks, especially of the coal beds, the structure and the life in the provinces named, appears to indicate that Upper Cretaceous time in that region was occupied by a single movement of subsidence, somewhat irregular, but, on the whole, persistent: that this was followed by a period of general and differential uplift, to be followed in turn by renewed subsidence, interrupted locally, from time to time, by pronounced movements of differential uplift. Comparison is made between this interpretation and the assumed conditions in the eastern United States and certain deductions drawn as to the point in the time scale at which the first general uplift occurred.

Relation of Physiographic Changes to Ore Alterations: Wallace W. Atwood.

While a land mass is being dissected, the groundwater table is slowly lowered through that mass, until, at the peneplain and base-level stages, the groundwater table remains almost stationary for long periods of time. During successive cycles of erosion the position of the base-level of erosion in the land mass being dissected must change, and, if climatic conditions remain constant, such changes are necessarily accompanied by changes in the position of the groundwater table. If the land mass is elevated, the base-level will be lowered through the land, and the groundwater table will be slowly lowered. When a land mass is depressed, the base-level of erosion and the groundwater table are elevated throughout that land mass. Moist climates will raise the groundwater table, and dry periods lower that table. As the groundwater table is raised or lowered, the zones in which the chemical changes associated with the secondary alteration of ore deposits take place are varied in thickness.

These facts indicate that physiographic studies may be profitably applied in the study of ore alterations, and conversely that the record of ore alterations may furnish important data bearing upon the physiographic evolution of the districts concerned.

The study of secondary ores by various investigators has called for intensive physiographic studies. During the past season field work was done in the vicinity of Butte, Montana, and Bingham Canyon, Utah, to determine the relationship of physiographic evolution to the secondary enrichment of ores in those regions. In this paper the problem of the application of physiography to the investigation of secondary ores was defined, and some of the results of the past season's field work were presented.

Graphic Projection of Pleistocene Climatic Oscillations: Chester A. Reeds.

Penck's curve, page 1168, "Die Alpen im Eiszeitalter," 1909, expresses graphically the climatic oscillations of the alpine district for Pleistocene and post-Pleistocene time. The key to the four glaciations and the three interglacial stages indicated in the curve was found in the four outwash deposits of glacio-fluvial streams on the northern foreland of the Alps in the vicinity of Ulm and Munich. Along the present stream valleys the glacio-fluvial deposits are arranged in terraces, the oldest occupying the highest position and the youngest the lowest level. When the key was carried in mind to the French and Italian Alps the remarkable association of these deposits on the northern foreland was found to be applicable throughout. Hence the names of four small tributaries of the Danube which cross the outwash deposits on the Bavarian plateau, Günz, Mindel, Riss and Würm, were applied by Penck and Brückner to the first, second, third and fourth glaciations. The deposits of the third or Riss glaciation in the Swiss and French Jura extend farther out on the foreland than the deposits of the other glacial advances, but in other districts the morainal deposits of the second or Mindel stage extend beyond that of any other, hence it is regarded as the most extensive of the four alpine glaciations. The morainal and outwash deposits of the first or Günz glaciation are least in evidence while those of the fourth or Würm glaciation, the last, are most in evidence.

That the temperature of the alpine region was considerably colder during the stages of glaciation than during the interglacial stages and the present which is at the close of the retreating hemicycle of the last glaciation, is shown conclusively by the depressed snow lines. Penck has determined their position in the Alps for all four glaciations. They have a distribution parallel to that of the present snow-line, but occupying lower levels, namely, Günz, 1,200 meters, Mindel, 1,350 meters, Riss, 1,300 meters, and Würm, 1,200 meters below the present snow-line. During the interglacial stages the snow-line was approximately 300 meters higher than the present one. From the Höttinger Breccia near Innsbruck Penck determined that there was a temperature variation of 1° C. for every 200-meter change in the altitude of the snow-line.

The unit of measurement which Penck used in estimating the duration of the Pleistocene period is the retreating hemicycle of glaciation of the fourth or Würm stage, better known as the post-glacial period. In the alpine district Penck and Brückner found that in this retreating hemicycle there were three minor advances called the Bühl, Gschnitz and Daun stadia. These advances were preceded by a prominent minor retreat of the Achen oscillation. From the lignite deposits of Dürnten, the deposits of the Muota deltas and the turf deposits in many of the glacial swamps it has been possible to estimate the duration of this hemicycle of glaciation in years, as follows:

Subdivisions of Post-Glacial Time

	Years
Achen oscillation	9,000
Bühl advance and retreat	5,000
Gschnitz advance and retreat	4,000
Daun advance and retreat	3,000
Age of copper	1,000
Post-copper time	3,000
Total	25,000

The estimate on the duration of post-glacial time in America is based chiefly on the recession of the waterfalls of Niagara and St. Anthony. Recently Coleman[4] made an estimate based on the rate of wave erosion on the shore of Lake Ontario and glacial Lake Iroquois. Twenty-five thousand years is a figure which falls within the estimates made by Coleman, Taylor, Lyell, Chamberlain and Salisbury. It is a bit under those of Fairchild, Sardeson and Spencer and above those of Gilbert and Upham. It is considered a conservative figure.

Penck states that it must have been 16,000 to 24,000 years from the Bühl stadium to the present, with 20,000 years as an average, and 25,000 to 40,000 years from the beginning of the Achen retreat to the present. In selecting a figure, however, which shall be used as a unit of measurement in calculating the duration of the entire Pleistocene period, he chooses 20,000 years as the length of post-Würm time.

The correlation of the mountain glaciations of the Alps with those of the Scandinavian continental ice fields of Pleistocene time has not been worked out in all regions, but there is sufficient information at hand to say that there were four advances of the continental ice over northern Europe which correspond to the periods of ice advance upon the alpine forelands. Geikie remapped in 1914 the second, third and fourth glaciation distribution in Europe. G. de Geer delimited the retreating stages of the fourth glaciation in the Scandinavian peninsula in 1912.

A correlation of American with European glacial deposits has been made by Leverett. By consid-

[4] Coleman, A. P., Proceedings, Twelfth Inter. Geol. Cong., Canada, 1913.

ering with Leverett[5] the so-called Iowan glaciation contemporaneous with the Illinoian it is possible to correlate the Günz glaciation with the Nebraskan, the Kansan with the Mindel, the Illinoian with the Riss and the Wisconsin, early and late, with the Würm. There are corresponding interglacial stages. With the time units of Chamberlain and Salisbury[6] 2, 4, 8, 16, in mind for the duration of the last three glaciations, based upon the degree of weathering of American glacial deposits, it is possible to construct a curve similar to Penck's, but differing in length and the number of units assigned to the interglacial stages. In tabular form the data appear thus:

Estimated Duration of Pleistocene Oscillations

	Reeds, 1914			Penck, 1909	Totals
Post-glacial....	25,000	25,000		20,000	20,000
Fourth glacial.	25,000	50,000		20,000	40,000
Third interglacial..	100,000	150,000		60,000	100,000
Third glacial..	25,000	175,000		20,000	120,000
Second interglacial..	200,000	375,000	12	240,000	360,000
Second glacial..	25,000	400,000	1	20,000	380,000
First interglacial	75,000	475,000	5	100,000	480,000
First glacial....	25,000	500,000	1	20,000	500,000
Pre-transitional.	25,000	525,000	1	20,000	520,000

Geologic Deposits in Relation to Pleistocene Man: CHESTER A. REEDS.

The present known distribution of Pleistocene man through southern Europe, the Mediterranean border and Java, points to the conclusion that this early man lived along the river courses, on the adjacent uplands, in caves and grottoes which overlooked well-defined river valleys and on the seashore. Human remains have been found entombed in a few caves within the region of mountain glaciation—for example, Frendenthal, Kesslerlock and Schweizersbild in Switzerland—but most of the finds have been made in the southern nonglaciated portions of Europe. The vicissitudes and the ameliorations of climate during the glacial and interglacial stages no doubt caused southward or northward migrations of peoples or encouraged congestion in the limestone caverns of Belgium, France, Germany and northern Spain. With the repeated formation of continental ice sheets on the Scandinavian plateau during periods of glaciation and their movement outward in all directions across the adjacent basins and lowlands of northern Europe, together with the appearance of ice caps on the high mountains of southern Europe, the lowering of the snow line on the mountain slopes, the development of snow caps on plateaus of but moderate relief, the extension of the glaciers into aprons and tongues on the piedmont areas and the choking of the river valleys with ice and deposits, glacial man must have felt that Snow and Ice were the governing forces. The warmer interglacial epochs were more to his liking. In the present terrace and loess deposits along the river courses and in the cave and grotto fillings, eight human culture stages have been delimited within recent years. They have been called, beginning at the bottom, pre-Chellean, Chellean, Acheulean and Mousterian as Lower Paleolithic and Aurignacian, Solutrean, Magdalenian and Azylian-Tardenoisan as Upper Paleolithic. In the cavern and grotto deposits of the Dordogne, southern France, most of the culture stages appear in regular geologic sequence one above the other. Human remains and culture stations of glacial, interglacial or post-glacial age have been found in approximately three hundred different localities.

[5] Leverett, F., *Zeitschrift für Gletscherkunde,* Vol. IV., pp. 282–83, 1910.

[6] Chamberlain and Salisbury, "Text-Book of Geology," Vol. III., p. 414, 1906.

Physiographic Features of Western Europe as a Factor in the War: DOUGLAS W. JOHNSON.

Every military campaign is controlled to some extent by the surface features of the country over which the contending armies must move. The physiography of a region may therefore profoundly affect both the detailed movements of armies and the general plans of campaign. An examination of the physiographic features of western Europe in the light of recent events enables one to comprehend more fully the strategic importance of many places mentioned in war dispatches and throws valuable light upon the question as to why the neutrality of Belgium was violated.

John Boyd Thacher Park. The Helderberg Escarpment as a Geological Park: GEORGE F. KUNZ.

A most important benefaction to the state of New York is the beautiful John Boyd Thacher Park, opened with appropriate ceremonies September 14, 1914. During the winter of 1913–14 the American Scenic and Historic Preservation Society received word of the intention of Mrs. Thacher, widow of John Boyd Thacher, to realize her generous purpose of donating to the state a superb trust of 350 acres of land for a public park,

as a memorial of her husband, and in March, 1914, a bill was introduced and passed in the legislature accepting the gift and constituting the American Scenic and Historic Preservation Society the custodian. The park embraces the most picturesque and geologically interesting part of the Helderberg range in Albany County.

The remarkable geologic formations to be seen in this park include one of the finest exposures of the Upper Silurian and Devonian strata in the country, and offer classic types of several formations, as is shown by the designations "Helderberg limestone" and "Helderberg group"; the rocks contain a great number of characteristic fossils, especially of marine forms. On the slope appear Hudson shales, and flaggy sandstones of the Hamilton formation crown Countryman Hill. The deep amphitheater at Indian Ladder has been worn out by the water of a small stream.

There is now a small museum and library in the park, and the Geological Survey has set up a bench-mark. It is hoped that very soon the cottage-building for the reception of guests will be completed, so as to afford comfortable shelter for visiting geologists who wish to study this Mecca of geologists. The library would be glad to receive geological publications having any bearing on the local conditions; such mail should be addressed to the curator of John Boyd Thacher Park, East Berne, New York. (By title only.)

The Relief of our Pacific Coast: J. S. DILLER.

The continental feature bordering the Pacific coast of the United States is a mountain belt of surpassing grandeur and composed in general of two lines or ranges of mountain elevations with a depression between. For the most part the two lines of mountains appear to be parallel with each other and the coast, the Sierra Nevada and the Cascade Ranges on the east and the Coast Ranges, including the Klamath Mountains of California and Oregon and the Olympic Mountains of Washington on the west, from the Mexican line to that of British Columbia. Cross folds connect the side ranges and separate the great valley of California from the Willamette Valley of Oregon.

The Sierra Nevada is composed of folded sediments and igneous rocks of various ages from Silurian to Jurassic, and faulted and tilted as one great block with long gentle slope to the west and steep slope to the east.

The Cascade Range is essentially volcanic and due mainly to volcanic upbuilding, though partly to uplifting, from Mount Adams in Washington to Lassen Peak in California, but beyond these limits the older crystalline rocks rise to the surface.

The Klamath Mountains are in large measure like the Sierra Nevada in their rocks, although more fossiliferous, but differ in structure, being characterized by broadly curved thrust faults with the overthrust into the concave curve and thus toward the Pacific ocean.

The coast ranges of California and Oregon are composed almost wholly of Mesozoic and Tertiary rocks. In California the coast range rocks are greatly crushed and faulted, but in Oregon the compression has been much less intense.

At eight o'clock P.M., on December 29, the society convened in the lecture hall of the Academy of Natural Sciences and listened to the reading by Vice-president W. Lindgren of an abstract of the address of the retiring president, George F. Becker. The title of his address was "Isostasy and Radioactivity."

In addition to the papers which were read at the general sessions, the following papers were presented in the sectional meetings of the society:

"Origin of the Red Beds of Western Wyoming," by E. B. Branson.

"Some New Points on the Origin of Dolomites," by Francis M. Van Tuyl.

"Range and Rhythmic Action of Sand-Blast Erosion, from Studies in the Libyan Desert," by William H. Hobbs (by title).

"Corrasive Efficiency of Natural Sand-Blast," by Charles Keyes (by title).

"False Fault-Scarps of Desert Ranges," by Charles Keyes (by title).

"Stratigraphic Disturbance Through the Ohio Valley Running from the Appalachian Plateau in Pennsylvania to the Ozark Mountains in Missouri," by James H. Gardner (by title).

"Preliminary Paper on Recent Crustal Movements in the Lake Erie Region," by Charles E. Decker.

"Quaternary Deformation in Southern Illinois and Southeastern Missouri," by Eugene Wesley Shaw (by title).

"Old Shorelines of Mackinac Island and their Relations to the Lake History," by Frank B. Taylor.

"Some Peculiarities of Glacial Erosion Near the Margin of the Continental Glacier in Central Illinois," by John L. Rich.

"New Evidence for the Existence of Fixed Anticyclones above Continental Glaciers," by William Herbert Hobbs (by title).

"Can U-shaped Valleys be Produced by Removal of Talus?" by Alfred C. Lane (by title).

"On the Origin of Monk's Mound," by A. R. Crook.

"Physiographic Studies in the Driftless Area," by Arthur C. Trowbridge (by title).

"Hemicones at the Mouths of Hanging Valleys," by Charles E. Decker (by title).

"Block Diagrams of State Physiography," by A. K. Lobeck (by title).

"Pre-Cambrian Igneous Rocks of the Pennsylvania Piedmont," by F. Bascom (by title).

"Magmatic Assimilation," by F. Bascom (by title).

"Hypersthene Syenite (Akerite) of the Middle and Northern Blue Ridge Region, Virginia," by Thomas L. Watson and Justus H. Cline (by title).

"Pyrrhotite, Norite and Pyroxenite from Litchfield, Connecticut," by Ernest Howe.

"Some Effects of Pressure on Rocks and Minerals," by John Johnston.

"Primary Chalcocite in the Fluorspar Veins of Jefferson County, Colorado," by Horace B. Patton.

"Recent Remarkable Gold 'Strike' at the Cresson Mine, Cripple Creek, Colorado," by Horace B. Patton.

"Platinum-gold Lode Deposit in Southern Nevada," by Adolph Knopf.

"Organic Origin of Some Mineral Deposits in Unaltered Paleozoic Sediments," by Gilbert van Ingen.

"Type of Rifted Relict Mountain, or Rift-Mountain," by John M. Clarke.

"Evidence of Recent Subsidence on the Coast of Maine," by Charles A. Davis.

"Basic Rocks of Rhode Island: Their Correlation and Relationships," by A. C. Hawkins and C. W. Brown.

"Acadian Triassic," by Sidney Powers.

"Geological History of the Bay of Fundy," by Sidney Powers.

"Alexandrian Rocks of Northeastern Illinois and Eastern Wisconsin," by T. E. Savage.

"Olentangy Shale and Associated Deposits of Northern Ohio," by Clinton R. Stauffer (by title).

"Diastrophic Importance of the Unconformity at the base of the Berea Sandstone in Ohio," by H. P. Cushing.

"Kinderhookian Age of the Chattanoogan Series," by E. O. Ulrich.

"Origin of the Iron Ores at Kiruna, Sweden," by Reginald R. Daly (by title).

"Origin of the Rocky Mountain Phosphate Deposits—Preliminary Statement," by Eliot Blackwelder (by title).

"Regional Alteration of Oil Shales," by David White (by title).

"Oil Pools of Southern Oklahoma and Northern Texas," by James H. Gardner.

"Natural Gas at Cleveland, Ohio," by Frank R. Van Horn.

"Origin of Thick Salt and Gypsum Deposits," by E. B. Branson.

"Crystalline Marbles of Alabama," by Wm. F. Prouty (by title).

"Devonian of Central Missouri," by E. B. Branson and D. K. Greger.

"Olentangy Shale of Central Ohio and its Stratigraphic Significance," by Amadeus W. Grabau.

"Hamilton Group of Western New York," by Amadeus W. Grabau.

"Extension of Morrison Formation into New Mexico," by N. H. Darton (by title).

"Geological Reconnaissance of Porto Rico," by Charles P. Berkey.

"Relation of Cretaceous Formations to the Rocky Mountains in Colorado and New Mexico," by Willis T. Lee.

"Post-Ordovician Deformation in the St. Lawrence Valley, N. Y." by George H. Chadwick.

The annual dinner of the society was held on the evening of December 30 and was attended by 140 of the members of the society and their friends. E. O. Hovey acted as toastmaster and the speakers of the evening were Messrs. W. Lindgren, H. F. Osborn, C. D. Walcott, C. R. Van Hise, W. W. Atwood and F. R. Van Horn.

In addition to the hospitality offered by the Academy of Natural Sciences, the Fellows of the society resident in Philadelphia entertained the Geological and Paleontological Societies and their friends at luncheon each day of the meeting and at a smoker given on the evening of the first day, at the close of the reading of the presidential address.

The officers elected for the year 1915 were Arthur P. Coleman, president; L. V. Pirsson, first vice-president; H. P. Cushing, second vice-president; Edward O. Ulrich, third vice-president; Edmund Otis Hovey, secretary; Wm. Bullock Clark, treasurer; J. Stanley-Brown, editor, and Frank R. Van Horn, librarian.

The next meeting of the society will be held at Washington, D. C., December 28–30, 1915.

Edmund Otis Hovey,
Secretary

SCIENCE

FRIDAY, APRIL 9, 1915

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE DEPLORABLE CONTRAST BETWEEN INTRANATIONAL AND INTERNATIONAL ETHICS AND THE MISSION OF MEDICAL SCIENCE AND MEDICAL MEN[1]

THE chief aim of my remarks is to point out the unique position which medical sciences and medical men occupy in the horrible war which is going on between civilized nations. International morality may possibly derive some permanent benefit from a conscious knowledge of this position. However, in order to make my point clear, I shall introduce it by a discussion of some aspects of ethics.

Moral philosophy assumes for granted that ethical relations of civilized men are safely established; it concerns itself merely with the question regarding the nature of the origin of ethical precepts. In general, it may be admitted that the vast majority of civilized men indeed do not question the correctness of ethical demands. But writers on moral philosophy fail to distinguish between *intra*national and *inter*national ethics. Hence, we find frequently that international occurrences are discussed from the point of view of intranational principles; international occurrences are brought before the forum of a supreme court of the world for judgment, but the merits and demerits of the cases are argued from the point of view of ethics which obtain in intranational moral relations. But the truth is that there is an abyss between the two domains of morality.

Let us first look at the status of intranational morality. The ethical relations

[1] Address delivered at the annual dinner of Columbia University Biochemical Association, March 26, 1915.

among civilized fellow men, united by bonds of race, nation or country, are firmly established. Justice and duty are deeply rooted conceptions, the compelling force of which is spontaneously recognized by all normal members of the individual community; the small fraction of dissenters consists of defectives and criminals. Sympathy, kindness, altruism and self-sacrifice are not enforceable human virtues, but are nevertheless profoundly appreciated and admired by the individuals of all civilized nations. Honesty is an indispensable virtue. In parenthesis I may, however, say here that to my knowledge "honor" is not among the general precepts of ethics. It is an artifact; it is mostly an artificial virtue of a class which considers itself as being above the simple requirements of justice and duty. It is not an unusual occurrence that in the name of honor a man may slay with relative impunity a fellowman whose home life he has dishonored.

From Sokrates to our day students of moral philosophy offered various theories concerning the nature of the principles underlying the "science of conduct." I shall not discuss the merits of the theories of Hedonism or Utilitarianism, the Law of God or the Categorical Imperative; they do not concern us here. But I have to refer to one theory which was not received with great favor and which had only a short life of popular existence. In the latter half of the last century, under the powerful influence of Darwin's theory of natural selection in the domain of biology, a systematic attempt was made by some philosophers (Herbert Spencer and others) to look upon ethics as a purely biological phenomenon. Family ties of lower animals, it was thought, developed into the ethics of civilized nations. Whether on account of the feverish social and altruistic activities which have been going on in the last decade or two and for which a biologic theory of ethics could hardly have served as a sufficient stimulus; or whether on account of the general decadence in popular enthusiasm for the theory of natural selection in general, the fact is that the theory of biologic origin of ethics seems to have been generally abandoned in recent years. But whatever we may think philosophically regarding the nature of fundamental origin of ethics, we can practically not deny that *morality is subject to evolutionary influences;* it has undergone and is continually undergoing development. Morality manifests a continuous growth. The development of savage races into cultured, ethical nations is a matter of historical record. In fact, the progessive widening which conceptions like justice or duty are continually undergoing within the confines of a nation is practically a matter of direct observation during an individual's lifetime.

I shall dwell here especially on two elements which are operative in this process. The foremost factor in the evolutionary progress of intranational morals is to be found undoubtedly in the intellectual activities peculiar to man. The growth and development of the sciences, of arts, music, poetry, literature and religion, from their rudimentary phases into their present high states, elevated the specific human character and favored the widening and deepening of morality of any individual nation or rather the morality of the individuals of which these nations are composed. The human intellect may or may not be the primary cause of morality; but the unfolding of human intelligence and the growth of intellectual activities specifically human, are undoubtedly important elements in the growth and development of specific human morality. This connection between intelligence and morality is practically a matter of direct observation.

On this basis the further assumption is justified, that even the conscious primitive morality of primitive man did not make its appearance abruptly. It developed very slowly, parallel, to a certain degree, with the development of man in the animal stage into man with rudimentary intelligence.

I presume, then, that conscious morality did not begin abruptly, but developed very slowly, parallel with and assisted by the development and growth of human intelligence. However, important as the human intelligence may be, evidently it is not the only controlling factor of morality. We see animals acting towards their fellow creatures in a manner which, if seen in human beings, we would consider as highly ethical. We all know how animals care for their offspring. We see dogs licking the wounds of their fellow dogs—an act resembling a samaritan service. We see altruistic activities in the communities of the bees and the ants. We designate these animal activities as instincts and we have indeed no evidence that a conscious morality is at the bottom of these phenomena. We have, however, to keep in mind that the harmonious relations between animals are observed only among individuals of the same species or race, or the same drove or swarm, whether they are presided over by a bell-wether, a queen or any other single leader, or have a democratic form of government with several contending leaders. Animals belonging to different species, races or strains get frequently into ferocious fights as soon as they meet, or as soon as there is a collision of interests and instincts. There are therefore sufficient reasons for assuming that the purely animal, instinctive element is involved to a considerable degree in the moral relations between individuals of the same group of human beings which have some efficient bond in common.

Now let us look at the moral aspects which international relations present. The history of nations, civilized or uncivilized, consists chiefly of a tale of more or less ferocious wars interrupted by periods of peace. War is nothing but wholesale murder; but the men of one tribe or nation who are murdering men of another tribe or nation have no idea that they are committing crimes; on the contrary, the more civilized individuals among the fighters are honestly possessed by the conviction that they are performing a moral duty. It is true that in times of peace citizens of one country enjoy in another country most of the privileges enjoyed by the citizens of that country. This is guaranteed by treaties. There are also international laws which even presume to prescribe the mode of warfare among the signatory powers. In time of peace a sincere friendly intercourse frequently prevails between the individuals of various nations. There are numerous international reunions for the purpose of furthering human knowledge and general human interests in all lines of human endeavor. All these facts may give us the right to speak of international morality. Nevertheless, even peace, especially peace in modern times and among civilized people, is practically nothing more than a *truce* during which nations are feverishly active in preparing for the next war, preparing to slaughter their apparent friends of to-day and to lead or to drive their own men to be slaughtered. During peace the leaders of nations are engaged in their military quarters or in their chancelleries in spying upon and intriguing against the nations with whom they exchange international amenities.

In international dealings cunning and deceit are essential factors in success; it is diplomacy. Honesty has hardly a place in these dealings. Only honor is the big

word which is loudly used by those who speak for nations as units, that sham virtue in the name of which crimes are committed by the privileged classes within each nation and in the name of which hundreds of thousands of honest and innocent citizens of various nations are murdered or crippled for life in the groundless and senseless strife of nations, brought about by the ambitions of unprincipled leaders. Furthermore, international relations in time of peace, which have an ethical appearance, are held together by flimsy ties. International peace conferences, international law, and peace treaties are merely scraps of paper which are torn to shreds at first sight of a bone of contention between nations.

In a previous section I insisted, and I believe rightly, that intellectual growth and activity are most important factors in the development and growth of intranational morals. What is the value and influence of intellectual growth and activity in international morals? Highly intellectual, civilized nations fight one another with a rage, a ferocity and with an intent to kill as probably did their animal ancestors of different strains or races, hundreds of thousands of years ago. But different species of another type of animals, let us say dogs and cats, are probably fighting to-day as their ancestors fought thousands of years ago, that is, tooth and nail, the only weapons at their disposal; their physical agility, their promptly acting reflexes, the finer developed senses and their remarkable instincts did not help them in developing new weapons or new ways of fighting; they had no human intellect. But the human race? We need not go back thousands of years. It suffices to compare warfares separated only by a hundred years. I need not enter upon a comparison of the rage, brutality and barbarity with which the wars are conducted; in this regard the present war is surely not behind its predecessors, and none of the cultured belligerent nations are ahead of or behind the others. Perhaps atrocities are at present not so much a question of barbarity as of success and efficiency—the idols of all walks of modern life. But as to destructiveness of human life, that cardinal aim in the war of nations, the progress made in this comparatively short span of human history is immense; it reads like a fairy tale. From high in the air a human bird directs you to turn a micrometer screw one millimeter or two and a huge shell annihilates hundreds or thousands of your enemy. A small group of human fishes bubble up in the vicinity of a huge leviathan, a dreadnought, and in less than ten minutes hundreds of men and millions of dollars are forever at the bottom of the sea. In a stretch of hundreds of miles, hundreds of thousands of soldiers are moved rapidly without a hitch from one place to another where they are needed most. The success is wonderful. In barely eight months millions of people were killed or crippled, perhaps as many more were made homeless and driven into starvation and billions of dollars borrowed and wasted. And that astounding result was not accomplished as in olden times, merely by extraordinary physical force or endurance or by that virtue in which wild beasts greatly excel men, the virtue of physical courage; it was accomplished by specific human ingenuity. Mathematics, physics, chemistry and other theoretical and practical sciences have made these awful results possible. In fact, practically every kind of intellectual activity took and takes a profound part in the bitter struggle which now goes on among highly civilized nations. Historians, philosophers, literary men and others are busy contrib-

uting offensive and venomous literature about their fellow men of nations with whom their country is at war, whose friends they were and whose honors they enjoyed. Poets sing the song of profound hatred and musicians write the melody to it, or compose war marches and songs. Religion offers an extraordinarily sad spectacle. Nations having the same religion and believing in the same God, pray to Him that He may help them destroy their enemy. Think of the robber and murderer who on his most godless errand prays to God for aid and guidance!

But here I must call your attention to a paradoxical but remarkable fact. Beastly as international morality is, when nations are at war, war nevertheless unquestionably elevates the *intra*national morality. The majority of citizens in every country are not idealists; in time of peace they comply with the laws of their country and fulfill their simple duties, not more and not less. But when their country is at war, a new spirit comes over them; they become altruists, they are ready to bring sacrifices, to lose their life or to become cripples for life. Whether a country is right or wrong with regard to the merits of a particular war in the eyes of an outsider, a neutral, this has no bearing upon the moral status of the man inside his country. That status is unquestionably elevated during war, and even after the war his relations to his countrymen remain on a higher moral plane. But this applies to civilized countries only, and of these only to such countries whose civilized citizens fight its battles.

Now let me recapitulate briefly. Human morality, whatever the nature of its origin may be, was and is subject to evolutionary influences. It began in the presavage state of men. Its development has been and is a very slow process. In its present state we must sharply distinguish between intranational and international ethics; there is an abyss between them. Intranational morals attained a high state. Intellectual activities of all kinds were and are most important factors in its growth. The morality in international relations, on the other hand, is generally low, and is frightfully bad when these relations are interrupted by war. War is an animal method of settling differences between two contending vicious species, and human intellectual activities greatly intensified the deadliness of the procedure. The efforts to create international laws for the purpose of restraining the ferocity of international struggles proved of little avail. We have cultured, civilized Germans, Frenchmen, Englishmen, and so on, but the world is not yet inhabited by cultured civilized men.

Apparently biological processes are operative in these horrible differences between the intranational and international states of morality. Intellectual activity is capable of efficiently assisting in the development of morality among individuals which are allied by some organic and social bonds; thus little or no resistance is offered to the beneficent intellectual influence. But individuals of different strains, with natural divergences and antagonisms, sustained by differences in education, customs, forms of law, etc., offer great resistance to the unifying influences of intellectual activity.

Accordingly, biological traits common to all animals, while some of them may exert a favorable influence upon the evolution, rate of growth and the direction of human morality, are surely not the main factors of its creation and development. On the contrary, in interracial and international relations many biological traits are profoundly inimical to a development

of proper moral ideals. Struggle for existence, uncontrolled physical strength and dexterity, love of fight, hate, rage, bravery, etc., are traits which the human race has in common with wild beasts, and an uncontrolled cultivation of these traits may often prove disastrous to all human morality. On the other hand, intelligence and intellectual activities are traits which distinguish man from beast. Their intense cultivation by civilized men has been the main cause of the high state of morality which prevails and is visibly progressing within the confines of civilized countries—the *intra*national ethics.

But now let us turn again to international ethics. We have seen that there is an abyss between international and intranational morality. We have seen further that war between civilized countries brings in modern times incomparably more frightful results than in previous ages, which is undoubtedly due to the astounding discoveries and inventions brought to light by the intense intellectual activities in the various cultured countries. Are discoveries and inventions, are even apparently sound intellectual activities, dangerous to international morality? Is this morality rather regressive instead of being progressive? And what can we do to make it progressive or to accelerate the imperceptible progress? The last question is the more important one, since it presents a practical and not merely an academic problem. In the following I intend to discuss some factors which may contribute in some modest way to its solution. I am fully aware, as all of you are, of the immensity of the problem, and I am aware, more than you, of the microscopical dimensions, metaphorically speaking, of your guest of the evening. But I shall act now as I always acted, upon the principle that it is neither good nor wise to possess less courage or more modesty than that drop of water which innocently and cheerfully undertakes to drill a hole in a rock.

As one who swore allegiance to the medical tribe, I shall begin by saying that the case of international morals is very bad indeed, but it is by no means hopeless; that only hopeful men are capable of attaining desirable results; that a remedy which promises to bring some help, be it ever so small, is not to be despised, and that a sum of such remedies may save even a bad case.

It seems to me quite probable that interracial and international morals are also subject to evolutionary influences and are undergoing a developmental process; but the progress is extremely slow because it has to struggle too much against the beastly nature of man. Even the development of international morality is a slow process; it must have taken many thousands of years before it reached its present stage. The present condition of international ethics would perhaps appear to us even quite high, if we had the means to compare it with its status of hundreds of thousands of years ago. This recognition, namely, that interracial and international morals are undergoing a progressive development, but that their progress is necessarily very slow, seems to me to be a very useful one. In the first place, because it encourages us to try to accelerate this progress, be the rate of the possible increase in the acceleration ever so small and be the means at our disposal for accomplishing it ever so meager. In the second place, it suggests to us to avoid looking for means of acceleration which are far out of proportion with the rate of the evolutionary progress; it is bound to fail and even to bring a temporary reaction, as history taught us over and over again.

I do not consider it as my province to try to discuss here all sorts of means which possibly may serve to increase progress in international morality. My chief purpose is, as stated at the beginning, to bring forward the value of medical sciences and medical men as efficient factors in furthering the progress of international morality. However, before coming to it, I wish to call attention briefly to a point or two to which reference has been made before. I believe, in the first place, that it is of prime educational importance to point impressively to the fact that there is a gulf between national morality, on the one hand, and interracial and international morality, on the other hand. A confusion between the two sets of ethics may harm the former and retard the possible progress of the latter. Citizens in neutral countries at all times, and citizens of all countries in times of peace, should know, should feel it deeply in their hearts, that war has not the slightest feature of morality, that it is simply a mode of settling differences between two or more strains of the human race in the fashion of wild beasts, increased in deadliness and ugliness by the activities of human intelligence. Here is an incontestable fact which gives pain and distress to the moral man; humanity, as a whole, shows that its moral conduct is not above that of vicious animals of various species. The discussion of the question as to who began the war and who prevents its conclusion is far from the mark; it is purely academic and is borrowed from the point of view of intranational morals. Justice and law had little to do with the beginning of the war and will have very little to say with its settlement. War is carried on by brute force and is settled by it with the aid of exhaustion and starvation. The many circumstances which lead to the numerous wars are mere incidents, but not the real cause of them. There is only one cause for all the wars and that is the possession by human beings of ferocious qualities peculiar to wild beasts, often entirely unrestrained and sometimes even directly cultivated to a higher degree.

In teaching intranational morality it ought to be made clear that physical strength, courage, dexterity and efficiency, useful and desirable as they are for the success in the life of the individuals and the nation they compose, are not moral principles. On the contrary, they may greatly magnify the evil results when used for unethical principles. Bravery and efficiency, which are most highly valued qualities in war, are qualities which are most destructive to your so-called enemy of to-day and perhaps your friend of yesterday and, moreover, perhaps of your friend of a day after to-morrow.

I now come to the chief point I wish to discuss. Short as the discussion will be, it is nevertheless the chief object of my entire discourse. I have stated above that the striking feature of this war, the great destructiveness of human life, owes its success to the employment of scientific results in carrying on the war. All sciences which may contain some practical element are contributing in some way or another to the wholesale destruction of human life. And not only the scientific results, but the scientists themselves are active at the front in laboratories improvised in large automobiles to search for new inventions and discoveries which may be of some immediate practical use or to predict the nature of the weather to be expected at different points, etc. And those who can not assist in such a direct way try to contribute to the spirit of war by spreading enthusiasm, by abusing the enemy, and by implanting hatred against it.

But there is one most inspiring exception

to this sorrowful rule. It is the utilization of the medical sciences and the behavior of medical men in the war. The results of medical investigations of the last few decades and the activities of medical men are of immense practical importance to modern warfare. In some of the former wars perhaps as many soldiers were wiped out in consequence of disease as were killed by the bullet or bayonet. The combined modern studies in pathology, bacteriology, hygiene, surgery, medicine, pharmacology, preparation of antiseptics, etc., have immensely reduced the ravages of war as far as sickness and injuries are concerned. Medical sciences and medical men are part and parcel of wars. But what is their ethical status with reference to strife of nations in comparison with other sciences, with other men of science, men of culture and education? Here is the answer.

None of the numerous important discoveries made in the medical sciences was ever used for the destruction of life or harming the enemy in modern civilized warfare.

Any discovery or invention made in the sciences or the practise of medicine, made in one of the warring countries, is freely given to the medical fraternity of a belligerent country—unless it involves a business relation over which medical men have no power. It is illuminating to read a review in an English medical journal of medical reports made at a German medical meeting held on a battlefield.

On the battlefield, on the firing line, perhaps in the midst of a hail of bullets and fragments of shrapnel, *physicians and surgeons, some of them volunteers, pick up wounded soldiers without regard to nationality, and treat friend and foe alike. It is practically of no moment to the sick and wounded soldier to which of the hospitals of the civilized belligerent nations he will be taken for treatment.* The physician, as a physician, knows no difference between races and nations, between friend and foe.

And withal physicians in every one of the warring countries are as good patriots, and are as ready to sacrifice their lives in their country's struggle, as any other patriotic citizen of his beloved country, with the only difference that he, *the physician, is merely ready to die, or to be crippled for life, in the service for his country, but he is not engaged in killing or harming any one belonging to another nation or country.*

There might be a few exceptions—it would be miraculous indeed if there would be none; any large group has its exceptions. But such few exceptions can not be held up against this wonderful picture which medical men present in war. And wonderful indeed this picture is. We have seen how low international morals are at all times; we see how infamously bad it is at the time of war and especially at the present ferocious war of cultured nations. And in the midst of this inferno we perceive a group of sciences which are in intimate contact with life and with war, and which nevertheless never contribute to the degradation of interracial and international morality. We perceive, furthermore, in every belligerent nation among the combatants a group of patriotic men, brave and ready for every self-sacrifice, who do nothing but render help to those who need it, who render it as members of their particular country, but render it to foe and friend alike. Here are representatives of humanity, as a whole, here is a most encouraging example of an elevated international morality.

This wonderful fact is not my discovery; it is a fact well established, and well

known to everybody, at least ought to be known by everybody. But *the calling of this fact to full consciousness of the members of our profession may render a great service to the progress of international morality.*

In the dawn of history, the medical man was also the treasurer of philosophy and morals. In the middle ages when knowledge became specialized, medical men more and more devoted their activity exclusively to medical practise. On account of the inefficiency of medicine at that time, medicine lost its prestige. However, in the recent decades medicine became a science and one marvelous discovery follows another, and the efficiency of medical practise increases rapidly. Medicine makes accessible to man uninhabitable parts of the world. It prevents disease, and with increased efficiency it learns to cure it. Medical sciences and medical men rose in the estimate of discriminating civilized mankind. *Could they (medical sciences and medical men) not become again bearers of the flag of morals, especially of international morals?* In the furious struggle which is going on at present amongst civilized nations international morals lost its friends; religion, sciences and the brotherhood of mankind proclaimed by the followers of socialism failed it; medicine alone did not desert it. In times of peace and for the purpose of furthering useful knowledge medical sciences and medical practises are working in separate groups, according to their specific aims. But all medical men of various shades and groupings ought to unite for this one high aim, *ought to establish a Medical Brotherhood for the Purpose of Upholding and Accelerating the Progress of International Morality.*

Every one of the scientific and practical men in medicine in our large country ought to join with enthusiasm such a missionary enterprise. The initiative ought to be taken by our large neutral country, but we may appeal to our neutral brethren in other neutral countries to join our crusade. However, we must not approach our medical confreres in the belligerent nations as long as the war lasts, lest it may be interpreted as an attempt to weaken their patriotism and their enthusiasm for the cause of the particular countries of which they are an integral part.

S. J. MELTZER

ROCKEFELLER INSTITUTE FOR
MEDICAL RESEARCH

CYRUS FOGG BRACKETT

BY the death of Professor Cyrus Fogg Brackett, which occurred on January 29, another link connecting the present with the past in the history of physics in this country was broken. Professor Brackett belonged to that group of physicists whose influence is now felt through their pupils in most of our universities. In the early days of his service at Princeton he was associated with Joseph Henry, who was a trustee of the college, and who took an active interest in the development of the department of physics under Professor Brackett's direction. His early studies came before the French influences had been superseded by the German, and his thinking always showed traces of that early training.

Professor Brackett, after graduation at Bowdoin College in 1859, studied medicine at the Harvard Medical School, and was graduated as Doctor of Medicine in 1863. He then returned to Bowdoin as a member of the faculty, and soon became professor of chemistry and physics. In 1873, on the advice of Professor Henry, he was called to Princeton as professor of physics. His coming to Princeton coincided with the foundation of the John Green School of

Science, and with a greatly increased interest in all scientific studies. He became at once the trusted adviser of the board of trustees in their endeavors to increase and improve the instruction in scientific subjects, and he was influential with the faculty in all matters connected with the development of the curriculum.

The physical laboratory as he found it had no equipment for research, and but little for demonstration. He felt it was his duty to devote himself to the improvement of the equipment, and to the organization of courses of lectures and laboratory instruction. As new apparatus came in he would put it together and test it, and when new apparatus was wanted which could be better made than purchased, he would construct it with his own hands. He was very skillful in all mechanical work, and much of the apparatus which he made is still in use.

At the same time he gave himself with entire devotion to his labors as a teacher. He thoroughly believed that physics should form an essential part of every student's course of study, and realized that if this were the case the course in physics should not be confined to the dry details of the subject, but should rather present the philosophy of nature. Owing to the breadth of his education, and to his unlimited interest in all scientific and philosophical questions, he was able to illuminate his subject with illustrations drawn from other sciences, and from the practical applications of science in the arts. His courses of lectures were not only instructive, but inspiring, and many of his students remember him with affection and respect as the most stimulating influence in their intellectual life.

Professor Brackett's interests were strongly excited by the development of electrical science, and of its applications to the comfort and convenience of life. He was acquainted with many of the great inventors by whom those applications have been made, and he became connected with some of their principal achievements as an expert adviser. He was occupied for several years as an expert, both in the laboratory and in the courts, with the questions arising in the contest concerning the invention of the telephone. He was thus led to give instruction in the engineering side of electrical science, and ultimately in 1889 to undertake the development of a school of electrical engineering. The course in this school, as he planned it, is designed for graduates, or for others already properly qualified by a sufficient knowledge of mathematics, physics and chemistry. One of its principal features is the emphasis laid upon the advanced study of general electrical science. His aim was to give his students a thorough general knowledge of their science, so that after a short experience in the practise of their profession they might qualify for positions in which scientific knowledge is particularly needed. Although, as he appreciated would be the case, the membership of this school has never been large, many of those who have gone out from it have justified the plan on which it was organized by rapidly attaining important places in the profession of electrical engineering.

Professor Brackett was for many years a member of the American Association for the Advancement of Science, and in 1886 was vice-president of section B. He was also a member of the American Philosophical Society. His knowledge of medicine and his general interest in the public welfare led to his appointment as a member of the State Board of Health of New Jersey. He served as president of this board for ten years. He was also for many years a member of the sanitary committee of

Princeton University, and was its responsible member in charge of the infirmary.

In 1908 he insisted on retiring from active service and was made professor emeritus. He at once turned his attention to research, for which he was so well fitted, and from which his devotion to professorial duties as a teacher had for so many years excluded him. He employed his technical skill in making optical preparations, and at last became interested in the construction of a ruling engine for the construction of diffraction gratings, of the sort known as echelette gratings. He devised a new method for the mechanical grinding of the screw, by which most of the hand labor that was needed in the methods previously used was avoided, and before his death he had the satisfaction of seeing the engine which he constructed producing gratings of satisfactory quality. With very little additional labor it will be fitted to do the work for which it was designed.

Professor Brackett was gifted with a most winning personality. He made friends of his colleagues and his pupils. The gift of the Palmer Physical Laboratory by Mr. S. S. Palmer, and its endowment by Mr. D. B. Jones and Mr. T. B. Jones, are monuments of the affectionate regard which he inspired in some of those who knew him. He was a wide reader, and an ingenious speculator on physical questions, and was always ready to contribute of his knowledge to those who came to him for information and advice. He will be remembered by all who came within the range of his influence as an inspiring teacher, an affectionate friend and a good man.

W. F. Magie

GEOGRAPHICAL MEETING IN NEW YORK

The second joint meeting of the American Geographical Society and the Association of American Geographers will be held in New York, Friday and Saturday, April 9 and 10, 1915. With the exception of Friday evening, the sessions will be held at the society's building, Broadway at 156th Street. President Dodge of the association will preside at the sessions. The joint meeting will be called to order on Friday morning by Mr. John Greenough, vice-president and chairman of the council, American Geographical Society. The Park Avenue Hotel at the corner of 33d Street and Park Avenue, will be headquarters for association members. The American Geographical Society has very generously asked all association members to be their guests at the hotel during the meeting, from Thursday afternoon, April 8, to Saturday afternoon, April 10. The arrangements make it desirable to dine together at hours to be announced at the session on Friday. It is hoped that as many members as possible will arrive on Thursday in time for dinner and the social gathering in the secretary's room at the hotel during the evening. The American Geographical Society has invited all members of the association to luncheon on both Friday and Saturday noon at a restaurant close to the society's building. Mr. George A. Plimpton has invited the members of the association, their wives, and all workers in geography in attendance at the meeting to meet at his home on Friday evening. Mr. Plimpton will speak informally on Early American Geography, and exhibit his complete and interesting library of early American texts in geography.

The scientific program is as follows:

FRIDAY MORNING SESSION (FROM ELEVEN O'CLOCK TO TWELVE-THIRTY)

"The Coast of New Caledonia," by W. M. Davis.

"Geography of the Navajo Country," by H. E. Gregory.

FRIDAY AFTERNOON SESSION (FROM TWO O'CLOCK TO FIVE)

"Utah, the Oasis at the Foot of the Wasatch," by Mark Jefferson.

"The Geographic Factor in Agricultural Industries," by C. S. Scofield.

"Origin of Some Desert Basins," by N. H. Darton.

"The Natural History of Ancient Vinland, and its Geographic Significance," by M. L. Fernald.

FRIDAY EVENING SESSION (AT 8:30, 61 PARK AVE.)

"Early American Geography," by George A. Plimpton.

SATURDAY MORNING SESSION (FROM TEN O'CLOCK TO TWELVE-THIRTY)

"Argentina and the Argentines," by Bailey Willis.

"Winter Weather as a Factor in the Great War," by R. DeC. Ward.

"The Muir Glacier in 1911 and 1913," by Lawrence Martin.

PACIFIC ASSOCIATION OF SCIENTIFIC SOCIETIES

At the Seattle meeting of the Pacific Association in May, 1914, the new constitution for a Western Division of the American Association for the Advancement of Science was accepted and recommended to the constituent societies for their adoption. It was determined that a two thirds vote would be necessary for adoption; that if this vote was secured before the meeting of the American Association at San Francisco in August, 1915, the work of the Pacific Association would be given over to the Western Division at the end of the August meeting, provided the Western Division was organized and ready at that time to continue the work of the Pacific Association. On March 20, 1915, the required two thirds vote was secured, and the Pacific Association is now ready as soon as the constitution is signed by the officers of the voting constituent societies to turn over the work to the new Division at the end of the August meeting of the American Association. The following societies adopted the new constitution in the following order: Biological Society of the Pacific Coast, Pacific Coast Paleontological Society, The Cordilleran Section of the Geological Society of America, The Seismological Society of America, Astronomical Society of the Pacific, The Technical Society of the Pacific Coast, The Cooper Ornithological Club, California Academy of Sciences, Puget Sound Section of the American Chemical Society, The Pacific Slope Association of Economic Entomologists, San Francisco Society of the Archeological Institute of America, and the San Francisco Section of the American Mathematical Society—twelve societies in all. The following societies rejected the constitution: The Philological Society of the Pacific Coast, and the San Francisco Section of the American Chemical Society. The Geographical Society of the Pacific did not reply. The Pacific Coast Branch of the American Historical Association will decide the question late in 1915.

Dr. Campbell, president of the American Association, has already appointed a committee to effect the organization of the division, and it will be ready in August to receive the work and the archives of the Pacific Association which will in this manner terminate a five years of active work.

J. N. Burman,
Secretary of the Pacific Association

Seattle,
March 30, 1915

SCIENTIFIC NOTES AND NEWS

Dr. Ira Remsen, president emeritus of Johns Hopkins University, will deliver the principal address at the formal opening of the new chemistry building of the University of Minnesota, on May 24.

At the recent commemoration day exercises at the Johns Hopkins University there was presented to the university by a committee of which Dr. William S. Halsted, professor of surgery, was chairman, a portrait in oil by Mr. Seyffert, of Philadelphia, of Dr. Franklin P. Mall, professor of anatomy in the university. Dr. Lewellys L. Barker, professor of medicine, made the presentation address.

Professor Charles S. Wilson, of the Cornell School of Agriculture, has been nominated by Governor Whitman as New York state commissioner of agriculture.

Officers of the Royal Astronomical Society have been elected as follows: *President,* R. A.

Sampson, astronomer royal for Scotland; *Vice-presidents,* J. W. L. Glaisher, Esq., Colonel E. H. Hills, W. H. Maw, Esq., H. H. Turner, Savilian professor of astronomy, Oxford; *Treasurer,* E. B. Knobel, Esq.; *Secretaries* A. S. Eddington, Plumian professor of astronomy, Cambridge, Alfred Fowler, Esq.; *Foreign Secretary,* Arthur Schuster, Esq.

NINE members of the American Red Cross Sanitary Commission, on their way to Servia to fight the ravages of typhus and other contagious diseases in that country, sailed on April 3 on the steamship *Duc D'Aosta,* for Naples. They were: Dr. Thomas W. Jackson, chief sanitary inspector; Dr. Hans Zinsser, bacteriologist; Dr. Andrew W. Sellards, Dr. George C. Shattuck, Dr. F. B. Grinnell, Dr. B. W. Caldwell, W. S. Standifer, Luis de la Pena and Hobart D. Brink. Dr. Richard P. Strong, the director of the commission, will meet them at Salonika. The expenses are being paid jointly by the Rockefeller Commission and the Red Cross.

ON the retirement of Mr. Otto H. Tittmann from the superintendency of the United States Coast Survey, recently announced from Washington, Dr. Henry S. Pritchett, president of the Carnegie Foundation, writes: "He entered the Coast Survey forty-eight years ago, and received his scientific training, as was the custom in that day, in the survey itself. Passing through all the divisions of scientific work, including hydrography, geodesy, terrestrial magnetism and tidal observation and prediction, Mr. Tittmann reached the highest scientific position in the survey and became in 1898 assistant superintendent, and in 1900 superintendent of the Coast and Geodetic Survey. His administration of this great post has been admirable, both from the scientific and the administrative point of view. His contributions to the determination of the figure of the earth, to the fixation of the boundary line between Canada and the United States, and his part in international geodesy have done credit to the country. With all his distinguished ability and service, he has united a modesty as fine as it is rare. It is a fortunate country which has such public servants."

DR. ARTHUR W. GOODSPEED, professor of physics in the University of Pennsylvania, has returned from Marburg, Germany, where he intended to pursue research work.

PROFESSOR LYNDS JONES, of Oberlin College, is planning to take a party of twelve students with an assistant to the coast of Washington, leaving Chicago June 21. Seven weeks will be spent studying the ecology of the region. From Neah Bay to Moclips the party will have as guides Guilliute Indians, making use of a gasoline launch and canoes along the coast. Special scientific investigation will be made of Coelentera, Echinodermata and Mollusca which abound between the tides. In addition, particular attention will be given to the kelp beds, the trees and bushes of the coast and the land animals of the islands. Members of the expedition will later visit the exposition at San Francisco.

THE address to the graduating class of the Michigan College of Mines is to be given this year by Professor James F. Kemp, of Columbia University, on April 16.

DR. JOHN F. ANDERSON, director of the hygienic laboratory, U. S. Public Health Service, addressed the Minnesota Pathological Society, on March 30, at the Institute of Anatomy. His subject was: "The Present Status of Our Knowledge of the Etiology and Distribution of Typhus Fever."

DR. EDITH J. CLAYPOLE, research associate in pathology in the University of California, died on March 27, in Berkeley, California. Dr. Claypole was well known as a teacher and investigator in biology and during recent years for her work on the differentiation of streptothrix infections in human beings, and on immunization against typhoid fever.

J. FOSTER CROWELL, known as an expert in railroad construction and hydraulic engineering, author of works on engineering subjects, including "Training a Tropic Torrent," "How Holland Was Made" and "Modern Wharves and Harbor Facilities," died in New York City, on March 29, aged sixty-seven years.

MISS MARY E. GARRETT died on April 3, in the sixty-second year of her age. Miss Garrett

took an active interest in education and gave large sums to the Johns Hopkins Medical School, Bryn Mawr College and the Bryn Mawr School for Girls in Baltimore.

Sir John Cameron Lamb, long connected with the British post office and chairman of many departmental committees, the author of works dealing with improvements in the use of the cable and the wireless telegraph and the construction of lifeboats, died on March 30, at the age of sixty-nine years.

The Royal Astronomical Society has by a vote of 59 to 3 passed a resolution as follows:

That this meeting approves of the admission of women as fellows and associates of the society, and requests the council to take all necessary steps to render their election possible.

The twenty-fourth session of the Marine Biological Laboratory of Leland Stanford Junior University at Pacific Grove, California, will begin on Monday, May 24, 1915. The regular course of instruction will continue six weeks, closing July 3. Investigators and students working without instruction may make arrangements to continue their work through the summer. The laboratory will be under the supervision of Professor G. C. Price, instructor in charge.

Professor J. Paul Goode, of the University of Chicago, has just issued the map of Africa in two forms, physical and political, and the fourth pair in the series of wall maps for colleges and schools upon which he has been at work for some years. The maps are 46 x 66 inches in size, the physical map printed in twelve colors, the political map in nine colors. These maps are entirely new, from original sources, and represent an earnest effort to achieve the highest quality of work in the map makers art.

The American Ornithologists' Union will meet in San Francisco, May 18–20. Eastern members will leave New York on May 6, reaching San Francisco on the evening of May 15. Two days, May 10–11, will be spent at the Grand Cañon, and two days and a half at Los Angeles. The sessions will be held at The Inside Inn, within the Exposition Grounds, with the annual dinner on the evening of May 18. Friday, May 21, will be devoted to a trip to the Farallon Islands, on the U. S. Fisheries steamer *Albatross,* and other trips will be arranged in accordance with the number of visitors and their inclinations.

The Southwestern Anthropological Society was organized on March 27, at Santa Fe. The report of the organization committee was unanimously adopted and Dr. Livingston Farrand, president of the University of Colorado and formerly professor of anthropology at Columbia University, was elected president. Dr. F. E. Mera was elected vice-president; Paul Radin, secretary, and Judge R. H. Hanna, treasurer. The members of the committee of research elected were Professor P. E. Goddard and Mr. Niels Nelson, of the American Museum of Natural History, New York City; Professor Franz Boas, of Columbia University; Professor A. L. Kroeber, of the University of California; Professor A. Tozzer, of Harvard University, and Mrs. Stevenson, of the Bureau of American Ethnology. Drs. Farrand and Radin are ex-officio members of this committee.

The magnetic survey vessel *Carnegie* left Brooklyn on March 6, bound on a two years' cruise, *via* the Panama Canal. The region of work will be chiefly in the Pacific Ocean and in the south Atlantic and south Indian oceans. A complete circuit of the earth between the parallels of 60°–65° south is to be attempted, November, 1915–March, 1916, starting out from Port Lyttleton, New Zealand, as a base. The *Carnegie* is commanded on this cruise by Mr. J. P. Ault, who will be assisted in the scientific work by Dr. H. M. W. Edwards (second in command) and by observers Johnston, Luke and Sawyer. Dr. Mauchly accompanies the vessel as far as Panama in order to assist in the inauguration of the work in atmospheric electricity which, with the aid of new appliances, is to be made a special feature on this cruise.

The appeal for subscriptions to the Sir William White Memorial Fund has resulted, we learn from *Nature,* in a sum of $15,000, contributed by 455 subscribers. The committee of the fund has decided that the most

suitable form which the memorial could take would be the establishment of a research scholarship in naval architecture to be named after Sir William White; and it has been arranged to hand over to the council of the Institution of Naval Architects the greater part of the funds subscribed so that a sum of at least £100 a year shall be available for the scholarship, which will be administered by the council of that institution. In addition, a medallion portrait will be placed in the new building of the Institution of Civil Engineers, and, finally, at the suggestion of Lady White, a donation of one hundred guineas has been made to the Westminster Hospital, where Sir William White passed away.

THE Washington Academy of Sciences is giving a series of lectures in the auditorium of the New National Museum, to which the public is invited. All these lectures are illustrated by lantern slides. The program is as follows:

March 18—"The Volcano Kilauea in Action," by Arthur L. Day.

March 25—"Nematodes, their Relations to Mankind and to Agriculture," by N. A. Cobb.

April 1—"High Explosives and their Effects," by Charles E. Munroe.

April 8—"Insects and their Relation to Disease," by W. D. Hunter.

April 15—"The Earth," by R. S. Woodward.

SOME years ago the buildings of the aquarium at Rothesay, which was for a time one of the well-known "sights" of the Clyde, were taken over by the Marquis of Bute. The buildings have through his generosity provided a local habitation for the Buteshire Natural History Society, of which Dr. J. N. Marshall is president, while they have also served to house a valuable and developing museum collection of the local fauna and flora. Lord Bute has now installed a small laboratory for biological research and provided the most necessary equipment, including a motor boat. Mr. L. P. W. Renouf, of Trinity College, Cambridge, has been placed in charge and, as he is desirous of making the laboratory a thoroughly convenient center for research work on the wonderfully rich marine fauna and flora of the Clyde estuary, he will be grateful for the gift of books and pamphlets bearing upon marine zoology and botany.

THE sundry civil act as passed by the last session of congress contained appropriations of $1,355,520 for the United States Geological Survey. Most of the appropriations for the Survey are included in this great government supply bill, but in addition to the above-stated amount $40,000 was appropriated in the legislative bill for rents, so that the total amount appropriated is $1,395,520. The principal items in the appropriations for the Geological Survey for the fiscal year ending June 30, 1916, are as follows:

Topographic surveys	$350,000
Geologic surveys	350,000
Mineral resources of Alaska	100,000
Mineral resources of the United States	75,000
Chemical and physical researches	40,000
Geologic maps of the United States	110,000
Gaging streams, etc.	150,000
Surveying national forests	75,000

The bill also appropriates $175,000 for printing and binding survey reports, to be expended by the public printer, and $1,500,000 for the new Interior Department building, which is to accommodate the office of the Secretary of the Interior, the Geological Survey, the Reclamation Service, the Land Office, the Indian Office and the Bureau of Mines, all bureaus of the Interior Department whose work is closely related to that of the survey and among all of which there is more or less constant cooperation. The total cost of the new building has been fixed at $2,596,000.

THE test and certification of watches, chronometers and other timepieces has been carried on for many years at the Kew Observatory in England, at the Besançon Observatory in France and at the observatories of Geneva and Neuchâtel in Switzerland, but no such tests have been made for the public in this country, except for a few years at Yale University many years ago. This line of work is now started at the Bureau of Standards, and Circular No. 51, entitled "Measurement

of Time and Tests of Timepieces," has just been issued, giving the regulations under which the tests will be made, the methods employed, together with sections on the use and care of watches, and on standard time and the sources of reliable time standards with which one may make frequent comparisons of his watch. This first edition of the circular announces the regulations for the test and certification of watches only; the test of other timepieces will be taken up later. For the purposes of test watches are divided into two classes, designated as A and B, adapted to watches adjusted for five positions and three positions respectively. The former test lasts 54 days, the latter 40 days. Both tests include a test of the temperature compensation of the watch, at temperatures of 5°, 20° and 35°. In the Class A test is also included an examination of the isochronism adjustment of the watch. Four tests a year are carried out, beginning on the second Tuesday in January, April, August and October respectively. The daily rates of the watches under the various conditions are determined within about 0.1 second. If the performance of a watch is within certain tolerances set for the different conditions, a certificate is granted showing the results of the test. If a watch fails to meet the requirements, a report is rendered showing wherein it fell short of the tolerances and giving its actual performance in the trial. Watches may be submitted by manufacturers or jobbers of watches, by retail dealers, or by individual owners of the watches, a fee being charged which is estimated to cover the actual cost of the test. It is expected that the tests will be especially valuable in cases where watches are to be used for scientific purposes or exploration, and also to purchasers of high-grade watches in giving them assurance that the watch is reasonably adjusted and in good condition at the time of the test. Copies of the circular and also of the application blank which must be filled out by those submitting a watch for test may be obtained upon request directed to the Bureau of Standards, Washington, D. C.

We learn from *Nature* that the movement started last year for the establishment of a Radium Institution in Manchester met with a generous response from the public. Thanks to the assistance of public men and the press, the committee that was appointed to carry out the scheme was able to collect a sum of about £30,000. The radium department was established at the Royal Infirmary, and began work on January 1 in a number of rooms that had been equipped at a cost of £1,000, and started with about 800 milligrams of radium metal. The contract for the radium, which cost about £21,000, was given to an American firm, and its delivery was not therefore interfered with by the outbreak of the war. In order to ensure the maximum efficiency, the radium committee, acting on the advice of Sir E. Rutherford, Sir Wm. Milligan, and other experts, took control of the equipment of the laboratories; and the standardization of the radium was done in the physical laboratories of the University of Manchester. The committee has also drawn up a scheme for the distribution of radium either in the solid form as applicators, or as emanation tubes from the liquid form, to the other hospitals in Manchester and the district. Dr. Arthur Burrows is the radiologist at the infimary responsible for the administration, Mr. H. Lupton is the physicist in charge, and Sir E. Rutherford acts as consulting physicist to the department.

Admiral Peary's arctic ship, the *Roosevelt*, has been sold and it is said that after it has been fitted with oil-burning machinery and other improvements, it will be sold to the Bureau of Fisheries of the Department of Commerce and Labor. The ship will be used in connection with the fisheries service in Alaskan waters, and will proceed through the Panama canal as soon as the refitting has been completed.

The geologists of the University of Texas, including the staffs of the school of geology and the bureau of economic geology, have organized the Texas Geological Club. The purpose of this club is to stimulate interest in geological matters at the university and in geologic research. Monthly meetings will be

held, and papers bearing on matters of geologic interest will be presented. The membership includes the following: F. W. Simonds, J. A. Udden, F. L. Whitney, C. L. Baker, H. P. Bybee, D. J. Jones, W. F. Henneger and Alexander Deussen.

IT is stated in *Nature* that the committee of users of dyes appointed to confer with the British Board of Trade as to a national dye scheme has come to a unanimous decision in favor of the adoption of a scheme which differs in certain important respects from those of the scheme previously made public. The proposal is to form a company with an initial share capital of £2,000,000, of which £1,000,000 will be issued in the first instance. The government will make to the company a loan for twenty-five years corresponding to the amount of share capital subscribed up to a total of £1,000,000, and a smaller proportion beyond that total. The government advance will bear interest at 4 per cent. per annum, payable only out of net profits, the interest to be cumulative only after the first five years. In addition, and with the desire of promoting research, the government has undertaken for a period of ten years to make a grant to the company for the purposes of experimental and laboratory work up to an amount not exceeding in the aggregate £100,000.

UNIVERSITY AND EDUCATIONAL NEWS

UNDER the will of the late General Charles H. Pine, recently published, Yale College will eventually receive an addition of $150,000 to the $50,000 scholarship fund established by General Pine about three years ago. The will also provides for the creation of a fund of $250,000 to be devoted to manual training of Ansonia boys and girls.

BY the will of General William D. Gill, of Baltimore, the Johns Hopkins University is made residuary legatee after the death of his wife. The bequest is to be used for the establishment of a chair of forestry.

AMONG the gifts recently received by Harvard University is one from Mrs. Samuel Sachs, of $2,500 for the purchase of a work or works of art for the Fogg Art Museum, and one of $3,005 from various donors for the Arnold Arboretum.

THE sum of $25,000 has been contributed by Mr. P. S. du Pont toward the University of Pennsylvania Museum extension building fund, which now amounts to more than $100,000. As soon as the fund amounts to half a million dollars, the building of the next extension will be started.

PROFESSOR JOHN A. MILLER, director of the Sproul Observatory of Swarthmore College, has recently been elected vice-president of the college.

DR. RUDOLF HÖBER has been appointed to the chair of physiology at Kiel vacant by the removal of Professor A. Bethe to Frankfort.

DISCUSSION AND CORRESPONDENCE

ON THE PROPOSED REORGANIZATION OF DEPARTMENTS OF CLINICAL MEDICINE IN THE UNITED STATES

TO THE EDITOR OF SCIENCE: Although Dr. Bevan's letter, published in SCIENCE in answer to Dr. Meltzer's, warns college presidents, laymen and university professors who are heads of laboratories to await patiently the findings of committee, consisting largely of practising clinicians, which is now considering the subject of the reorganization of the teaching of clinical medicine, yet in spite of the implied preemption of the subject it seems possible that even a university professor may be allowed to express his views.

For many years scientific work has been accomplished in this country in laboratories associated with the medical sciences, work which has received world-wide recognition. In other instances, clinicians have associated themselves with laboratory men, and have produced results which are known in the great foreign clinics. One might refer to the work of Coleman, of Joslin and of Howland as examples. This represents the cooperation of the laboratory and the hospital which has yielded and is yielding valuable results. There can be no question of the value of sympathetic and friendly cooperation of this sort.

The third stage, that of independent re-

search by the clinician, is the goal toward which the better schools of the country are striving to approach. It is this which led to the recent conditional gifts of $1,400,000 and $750,000 from the Rockefeller Foundation to the Johns Hopkins and to the Washington University. The spirit of modern medicine is that of scientific inquiry into the cause and cure of disease. This spirit can only be imparted by men who are themselves makers of modern knowledge. It is said that science does not explain all things and it is asked why should science be followed? The answer to this question should be, more science, to explain the unknown facts.

It is frequently set forth that there are two subdivisions of medicine, medicine as an art and medicine as a science. The impression is conveyed that medicine as a research science is not the object of a department of medicine. For this reason, the cooperation of the scientific departments is often asked. Innumerable schemes for "correlation" have therefore been presented to various medical faculties throughout the country. "Correlation" in this interpretation signifies that the scientific departments are to give instruction in the clinical years along the lines of the developments of modern scientific research. The oft-repeated request for correlation in this sense shows that there is something lacking in the clinical instruction which should be there.

The medical students of the United States are thoroughly grounded in the fundamental sciences during the early years of association with their schools. The fundamental sciences are largely unknown to the rank and file of the clinical teachers. This leads the latter to ridicule the knowledge which the students, with much labor and care, have sought to acquire. One of two results follow; either the student joins the instructor in belittling the laboratory teaching, or the student, being better informed than the instructor, feels ill satisfied with his opportunities.

The situation is something like this. There is a true scientific medicine based upon the application of research medicine in the clinic. The modern medical student is entitled to this kind of instruction for the fulfilment of his highest development. Can he get this? The answer is found in the argument offered in England as well as in the United States, that the department of medicine should be devoted to the teaching of medicine as an art. It follows that the direction of research is outside its capacity.

Let this problem be examined a little more closely. Many medical schools have recently purchased costly string galvanometers for use in affiliated hospitals. This apparatus is of service in certain diagnoses. As an instrument of research it might perhaps yield a brilliant discovery if used by a man who had been constantly engaged in the study of the phenomena of the circulation during a period of say five years. To the ordinary operator it has no more power of revealing new truths than would a Morse telegraphic outfit.

The truth of the matter is that, as a country, we have produced few men in medical science. This is frankly because the teaching of medicine has not been in accordance with modern science. The staff of the medical department should consist of men, themselves devoted to medical science, capable of carrying it on, brought up in the air of it and blessed by the enthusiasm of it. Such men should be produced under the leadership of the professor of medicine.

The true remedy is that the clinical departments furnish instruction along modern scientific lines. Other remedies are only temporary palliatives. The medical school owes a duty to the public. Personal ambition, even though unconsciously exercised, should not be allowed to frustrate the fulfilment of the duty to the community which the college lives to serve.

The schools are brought face to face with the question whether their policy will be to advance along modern lines or stand still yet a little while.

It is impossible in any faculty to approach this subject without hurting the feelings of true and honorable men, men who deserve well of their country and who are not to blame for the present situation brought about by an

altered trend of educational thought. It is, therefore, extremely difficult to speak of these matters without seeming to be both unkind and unjust. On the other hand, if no word is spoken, blame for cowardice is incurred.

It is the current opinion of the laboratory departments that medicine should be taught as a science by men who are scientific investigators. It is their hope that departments of medicine can be recognized so that this reform can be put into effect. We must think not of ourselves but of the present and the future. Only reorganization along modern lines will bring the best trained students. One needs but have one's touch on the scientific pulse of the country to realize the absolute verity of this statement.

The medical teaching of Friedrich Müller is conceded to be the best in the world. This is his own description of it.

At half-past eight I go to my institute, at ten to the wards. May I explain? My clinic (at 9 A.M.) is in the theater and to this theater the patients are brought, and I show the patients before my students and examine and explain the cases. This takes an hour, and then I go with a part of my students, which changes every day, to the wards and instruct them personally. This takes another hour. Then I go round the wards with my assistants and it is one or half-past one when I have finished. At least three times and in the winter term four times a week I go to my institute in the afternoon and give a general lecture. I lecture upon the diseases of the brain, the diseases of metabolism, diseases of the respiratory system and so on over certain parts of the whole province of medicine. My assistants are in part municipal, paid for by the state. I have one assistant in biological chemistry, another in chemistry, one working on nervous diseases, one doing bacteriological work and making a vast number of tests, Wassermann tests and so on. If I have a case, say, of typhoid fever, I give the proofs to the assistant last named, if I have a nervous case, to the nerve specialist. Any question of metabolism or chemistry I work out with my chemical assistants, and I work with them. I go on with research work and I do this work in connection with my assistants. . . . I have my own laboratories. I have a large laboratory for chemistry. I have a laboratory for physical examinations and especially for pathological anatomy, then one for bacteriology and for the Wassermann test, and so on. We have a large building for laboratory work connected with my clinic and governed by me. . . . Is it really necessary to incur such great expenses? Would it not be possible to conduct the school for the common practitioner in the old well-established manner? No. The general medical practitioner has always and everywhere to deal with the highest good, with the health of his fellow creatures and he must become more and more even in the remotest village the promotor of public health and therefore he must be an educated man. In his responsible vocation he must have some ideal which elevates him above the daily sorrows and disappointments of life. And he will find his refuge in his science. Only a good scientific education will enable him to follow the progress of medicine with critical understanding. Without a good scientific training he would sink into mere routine.

Let these words sink into the understanding.

Objection may be raised that no man in America is fit to conduct a clinic in any way similar to Friedrich Müller's. To say that is to insult the intellectual capacity of the country. It is admitted to-day that we lead the world in biology and in biological chemistry. To state that it is impossible to conduct medical instruction along the lines of what is admitted to be best, is inexcusable sophistry.

In conclusion, it is suggested that departments of medicine be organized under the leadership of individuals who will develop scientific research, and who will be placed upon a salaried basis with prohibition of private practise during a period of five years. The facilities for medical research in the hospital should be freely open to all at present in connection with the schools. The proper development of this scheme would take the whole of a man's time during the first five years. At the end of that time it will be evident whether it is necessary for a master of medical science to have that sharpening of the wits which an outside consulting practise is supposed to produce.

These words have not been written in a spirit of personal antagonism to men of the older order, for the writer has lived long enough to desire to avoid arousing such antagonism. But he feels that they bear the mes-

sage of the modern educational world and that he would be recreant to his sense of truth if he held his peace. GRAHAM LUSK

LETTER FROM PROFESSOR ED. CLAPARÈDE

J'APPRENDS de divers côtés que "Science" a reproduit une nouvelle d'après laquelle j'aurais dû démissionner de mes fonctions à l'Université de Genève. Cette nouvelle est entièrement inexacte. La presse allemande, qui l'a d'abord propagée, m'a confondu avec un de mes cousins, professeur de droit germanique à Genève; celui-ci a en effet été suspendu provisoirement de son enseignement pour avoir, dans son cours, reproché à la population civile belge d'avoir tiré sur ses agresseurs allemands.

Au moment ou ces incidents se sont produits, j'étais mobilisé, à la frontière, comme médecin d'un bataillon de montagne. J'y suis donc entièrement étranger. Mais, puisque mon nom a été prononcé, permettez-moi d'ajouter, pour éviter tout malentendu, que je ne partage aucunement la manière de voir de mon cousin, dont la mère est allemande, et qui a été lui-même élevé en Allemagne, ce qui explique suffisamment son manque d'objectivité en cette affaire. ED. CLAPARÈDE

FACULTÉ DES SCIENCES DE GENÈVE

SCIENTIFIC BOOKS

Text-book of Embryology. Vol. I. Invertebrata. By E. W. MACBRIDE, M.A., D.Sc., LL.D., F.R.S. London, Macmillan & Co. 1914. Pp. 692.

"The design of this text-book of embryology of which this is the first volume, is to associate the structural development of embryos with broad generalizations of what is known of their physiology. Attention will be drawn, for instance, to the correlation between the function of certain organs of a larva and its habit of life, and, in a more general way, between function and habit and the course of development. Reference will be made to some of the more striking results obtained by experimental embryological research. Attention will be drawn to gaps in our knowledge which indicate promising fields for research."

These words by the editor, Professor Walter Heape, introduce a work which promises to be as useful to the embryologist as is the Cambridge Natural History to the zoologist. Two other volumes are to be included in the work, one on the "Lower Vertebrata" by Professor John Graham Kerr and one on the mammals by Mr. Richard Assheton, both announced to be in press.

The volume before us measures 692 pages and is illustrated by 468 well-executed figures. The treatment is necessarily very succinct, as will be apparent when we consider that Balfour's treatment of invertebrata in his "Comparative Embryology" of 1885 was almost equally extended, and that Korschelt and Heider devoted 1,509 pages to the same groups in 1890–93. Professor MacBride's treatment, of course, includes later investigations also. In each phylum at least one type is selected for detailed description of the entire life history, and in the larger phyla each class may be so represented. Comparative data are then discussed; the experimental embryology is then treated, in some groups at least; and in conclusion the phylogeny of the phylum is considered from the point of view of the developmental history. This method admits both of considerable detail in the treatment of the type forms, and also of succinctness in the consideration of the comparative data. It avoids the vicious habit of constructing life histories from pieces of different ontogenies, and at the same time preserves some advantages of the comparative method.

The descriptive part of Professor MacBride's book is well done, and will be most useful. Special note should be made of the adequate descriptive treatment of cell-lineage hitherto lacking in text-book form. A selected list of literature follows each chapter, and the index appears to be very full. The practical embryologist will find methods of study in many places.

In such a book very much depends on the point of view of the author. The material is so great that rigid selection has to be practised: what is to be rejected, what retained and what principles are to be emphasized? There is no doubt about the point of view of Pro-

fessor MacBride; he stands firmly by the descriptive method, and the phylogenetic point of view as fundamental. All else is secondary: "It is, therefore, of the essence of *comparative embryology* to separate the fundamental ancestral traits of development from the superficial and secondary, and this is the task that has been patiently pursued for the last thirty years." If the results are considered disappointing, this is due largely to the human failing of lack of patience; and if divergences of opinion with reference to phylogenetic problems seem irreconcilable, in what better position are the adherents of the experimental analytical school? Are not opinions equally diverse and irreconcilable there? "The real truth is that experimental embryology is an adjunct and not an alternative to comparative embryology."

As good an illustration of the author's preferred form of generalization as the book affords is contained in the following quotation: "We are thus led to form the following conception of the past history of the lower Metazoa. A widespread and dominant race of blastula-like animals once swarmed in the primeval seas. Some of these took to a creeping life and eventually gave rise to the group of sponges; others kept to the free-swimming life and developed into planulæ, and so gave rise to the Cœlenterata. Some of these planulæ, by the specialization of the cilia into comblike locomotor organs, became Ctenophora; whilst the remainder adopted a fixed life and attached themselves by their aboral poles. This change occurred in the different divisions of the stock at different stages of the evolution of the internal organs of the planula ancestor, and in this way the groups of Hydrozoa, Scyphozoa and Actinozoa arose."

One is tempted to ask are such questions really the fundamental questions of comparative embryology? No one doubts the broad fact of evolution; nor can it be questioned that embryology is a strong aid to comparative anatomy and paleontology in the investigations of relationships. But the method has its limits, which seem to be surpassed in the above citation.

The experimental method in embryology is not a mere adjunct to comparative embryology of this sort. Indeed, experimental embryology has contributed very little to the phylogenetic interpretation of ontogeny, and in the very nature of things it is impossible that it should do so.

We have in fact two quite radically distinct points of view in embryology, viz.: the comparative anatomical and phylogenetic represented by Professor MacBride, and the functional analytic. Both rest, of course, upon descriptive embryology. Experimental methods are more or less applicable to both. But whereas their use for phylogenetic purposes must be limited to relatively simple purposes, such as determination of origins of parts where purely observational method fails, and can be of no service for the more general problems of phylogeny, experimental methods contribute the essential data for functional analytic problems of embryology, and are absolutely necessary for the investigation of all the more fundamental questions.

The phylogenetic and the functional analytic points of view in embryology diverge from a common basis of observation and experiment. Experimental embryology is not merely an adjunct to comparative embryology. The broadest aspects of phylogenetic embryology must forever, so far as we can see, remain matters of opinion, which can never be subjected to crucial experimental investigation. The reaction against this type of embryological research is therefore due not merely to lack of patience, but also to lack of confidence. That there remains much important work to be done of a purely descriptive character in embryology goes without saying; it is being produced all the time; but in the best works of recent years there is a notable reserve with reference to phylogenetic speculation.

Professor MacBride has selected and limited his material according to his point of view. One result is an altogether inadequate treatment of general and also experimental embryology. In this there is no lack of consistency, and it is therefore not in itself a matter for

just criticism. But certain regrettable mistakes occur in this part of the subject: for instance on page 3 it is stated that the terms oocytes and spermatocytes of the first order are applied to the germ-cells at the end of the period of growth, whereas these names are usually applied from the beginning of this period. On p. 16 the chromosome interpretation of Mendelian phenomena is given incorrectly, but is partially corrected in a footnote; on page 17 increase of "alkalinity" of the sea water is attributed to addition of butyric acid; evidently a slip. On p. 524 Morgan is credited with the discovery of inducing artificial parthenogenesis in sea urchins by treatment with hypertonic sea-water, and Loeb stated to have confirmed this result in 1910. Loeb, of course, made the original discovery in 1899. Several other similar errors occur.

Professor MacBride's volume is to be welcomed as a useful account of descriptive invertebrate embryology. But, to complete the series in which it belongs, there is a need of a volume which shall treat the cytological, functional analytic and general problems of embryology, which seem to the writer to constitute the most significant aspects of the embryological research of the last thirty years.

F. R. L.

An Introduction to the History of Medicine, with Medical Chronology, Bibliographic Data and Test Questions. By FIELDING H. GARRISON, A.B., M.D. W. B. Saunders Company. 1914. Pp. 1–763, illustrated with numerous portraits of eminent men, to which is appended an extensive bibliography covering 18 pages.

The author, in his preface, states that "the object of this book is to furnish the medical student or the busy practitioner with a definite outline of the history of medicine . . . ." But it is apparent, even on a hasty examination, that the work is capable of much wider usage and may easily be regarded as the most convenient volume of reference on the historical phases of medicine which has been issued recently in the English language. It ranks with the larger and more extensive works of Haeser and of Neuberger, Puschmann and Pagel, though more modest in scope.

The work bears clear evidence of its author's intimate association with the best medical library of the continent and he has made free use of the extensive material in the Surgeon General's library. The volume is chiefly a biographical study of the development of modern medicine, the characters being fully portrayed or briefly mentioned as a particular phase of their career bore an impress on the period or on a certain phase of medicine. One is thus compelled to search in several places for the details of any one man, and even then he finds many only scantily given, this being in accord with the author's views of writing a history of medicine. Both the men involved and the condition of the times in which they worked united to produce the final result.

From the viewpoint of anatomy the work is especially useful. Anatomy has been given its widest application and all phases of biology bearing on the development of medicine have been discussed, with brief or extensive mention of the more eminent men who have had a part in the development of anatomy, not only as directly applied to medicine, but in the purely scientific aspects of the science. Not only is mention made of the men who have been influential in the development of anatomy, but the political conditions of the times in which they worked are discussed. Their more important discoveries are given with, in many cases, exact references to the literature where they were formally discussed; thus adding immensely to the usefulness of the volume. The titles of the more important larger works of many of the prominent anatomists of all time are given, with date and place of publication. The early writers such as Galen, Hippocrates, Fontana and others are treated with especial care and notices of their writings are accompanied by useful notes as to number of editions, translations and commentaries with a statement of which are considered the most authoritative. These notes will save the student just beginning the study of the history of anatomy many blunders and much valuable time.

A glance at the first few chapters will give an idea of the scope of the work.

The first chapter is entitled, "The Identity of all Forms of Ancient and Primitive Medicine." It is a discussion from an ethnological standpoint of what has been determined concerning the condition of medicine among primitive races of ancient and modern times, in which are found traces of modern tendencies in medicine. Chapter II. is given up to Egyptian medicine. The chapter opens with a brief discussion of the fossil remains of man leading up to a statement of the antiquity of Egyptian civilization. Our author says: "At the same time the gap between paleolithic and neolithic man is much greater than that between the people of the late Stone Age and the civilizations of Egypt and Mesopotamia." The following pages are devoted to a discussion of medicine among the Egyptian peoples from the time of the earliest known physician I-em-hetep (4500 B.C.) to the time of the predominance of Greek thought. The most important Egyptian medical documents are the papyri of Brugsch, Ebers and Hearst, the chief of these being probably the Ebers papyrus, which was discovered by Georg Ebers at Thebes in 1872 and dates back to 1550 B.C. It is interesting to note the absence of all anatomical learning in Egypt until the time of the introduction of Greek thought which resulted in the famous Alexandrian school.

Chaper III. is devoted to Sumerian and Oriental Medicine. "To sum up what we owe to Oriental Medicine, the Babylonians specialized in the matter of medical fees, the Jews originated medical jurisprudence and public hygiene and ordained a weekly day of rest, and the Hindus demonstrated that skill in operative surgery which has been a permanent possession of the Aryan race ever since."

Chapter IV. treats of Greek medicine and is divided into three sections: (1) Before Hippocrates, (2) The Classic Period (460–146 B.C.), (3) the Græco-Roman period (146 B.C.–476 A.D.). Chapter V. gives a discussion of the Byzantine period (476–732 A.D.). "Although the Byzantine power lasted over a thousand years (395–1453 A.D.) medical history is concerned chiefly with the names of four industrious compilers (Oribasius, Aetius, Alexander of Tralles, and Paul of Aegina) who were prominent physicians in the first three centuries of its existence." Chapter VI. is devoted to the Mohammedan and Jewish periods (732–1096 A.D.). The titles of the next two chapters, "The Medieval Period" (1096–1438), "The Period of the Renaissance, the Revival of Learning and the Reformation" (1438–1600), will give an idea of the trend of the work.

In a compilation of such magnitude it is impossible that all errors should be avoided, and if attention is called here to a few errors in proof-reading it is with no thought of detraction, but with the hope of adding to the usefulness of the work. On page 24, 13th line from the top *metal work* is evidently intended, instead of mental work as it is printed; on page 184 the last year of Robert Hooke's life was *1703*, instead of 1763 as printed. In the index to personal names the page reference to Carl Ferdinand von Arlt should be *549*, instead of 547, McClung should be *474*, instead of 592. In the index to subjects (p. 761) Sex, determination of, should read *474* instead of 592. These defects are of minor importance, but are rather annoying when one has to search for the correct page. In four weeks' almost continuous use of this volume the above errors are the only ones which have come to my notice.

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THE NATURE AND ORIGIN OF FIORDS

There are two groups of geologists whose ideas regarding the origin of fiords are mutually opposed. The first group may be designated as the "glacialists," because in their opinion all the phenomena peculiar to fiords may be explained as the result of extensive glacial over-deepening of pre-glacial river valleys near the sea. The second group, or "nonglacialists," reject the theory of ice erosion, and attempt to account for the phenomena of fiords in other ways.

Members of the non-glacialist group are by no means in agreement among themselves as to the origin of fiords. They agree on one thing only,—that ice did not excavate these deeply submerged canyons. Some consider fiords the product of normal stream erosion followed by a partial submergence which permitted the valleys to be drowned. Others think that peculiar jointing of crystalline rocks enabled streams to carve peculiar valleys which were later submerged. A few even appeal to "some force not yet known to the geologist." Formerly many observers were inclined to regard every fiord as either a gaping chasm or a rift valley formed by the dropping down of a narrow strip of the earth's crust between two parallel faults. This tectonic theory of the origin of fiords, once much in vogue as an explanation for all valleys, is now generally regarded as obsolete. It is this theory which Professor J. W. Gregory defends in a spirited manner, in his recently published book on "The Nature and Origin of Fiords."[1]

Gregory divides his volume of more than 500 pages into three parts. Part I. outlines the problem which fiords present to the geologist, and discusses at much length different classifications of shorelines. Perhaps most readers will feel that here the author has laid undue stress on unimportant details of classifications which are empirical at best, and would have welcomed some attempt at a classification more truly genetic than any of those considered. In Part II., comprising about two thirds of the printed text, the author describes the fiord systems of the world, with the object of proving that the fiords of each district can best be explained on the basis of the tectonic theory. With the fiords of Norway, New Zealand, and other typical fiord areas, he classes the drowned valleys of the Dalmatian coast and other submerged normal river valleys which few besides the author would regard as fiords. Part III. is in part a résumé and amplification of the author's arguments against the glacial theory of fiord formation and in favor of the tectonic theory; and in part an elaboration of a theory of polar oscillations which might fracture the earth in such a manner as to explain the actual distribution of fiords. For in the author's opinion "the ultimate cause of fiords is the rupture of wide areas of the earth by the pulsation due to the titanic forces started by those disturbances which upheaved the existing mountain systems of the world."

The book is abundantly illustrated with sketch maps and diagrams and a limited number of excellent engraved plates. A partial bibliography of the subject of fiords covers 26 pages, while the text is filled with citations from the works of other investigators. Subject, authority and locality indexes are provided. A fairly long "errata" slip suggests inadequate proof-reading, and appears itself to stand in need of revision. Thus a reference to page 468 tells us that the sentence "The occurrence of the chief fiords and mountain-systems on the western sides of the continents is probably a consequence of the rotation of the earth from east to west," should be made to read "is probably a consequence of the rotation of the earth whereby raised areas lay from east to west." (Presumably "lay" should be changed to "lag.") But there is inserted on page 468 another erratum slip which advises us to read the sentence as follows: "The occurrence," etc., "is probably a consequence of the rotation of the earth from west to east, whereby raised areas lag." The reader may take his choice of these corrections; but after he has arranged this sentence satisfactorily his troubles are not over, since three additional corrections must be made in the two sentences which succeed it. Under such circumstances the reader may be pardoned if he is unable to discover what the author meant to say.

A word of explanation may properly precede the more detailed examination of Gregory's book. When an author of recognized ability produces a book which, however valuable, does not contain much novel material nor many

[1] "The Nature and Origin of Fiords," by J. W. Gregory. John Murray, London, 1913. Pp. 452.

new interpretations, a brief summary may give a fair conception of the nature of the work. When an author of no standing advocates unusual or startling interpretations, a very short review may suffice to characterize his effort. But when a writer of good standing, profiting by personal observations over an extended field, decides to support in an elaborate treatise a theory rejected as untenable by most of his colleagues in the science, something more than passing notice is required. "The Nature and Origin of Fiords" is the most elaborate work on this subject which the reviewer can recall. In it the well-known author of "The Great Rift Valley" supports a theory which the reviewer in common with most students of land-forms regards as untenable. The reasons for not accepting Gregory's arguments and conclusions should therefore be made plain.

Gregory's book was written primarily to disprove the glacial theory and to establish the validity of the tectonic theory of fiord origin. One might anticipate, therefore, that the author would set forth in the clearest terms the essential points of each theory, and more especially the critically important points of contrast between the two. Only after such an analysis would the reader be adequately prepared to weigh the evidence for and against the theories, and to decide intelligently between them. Unfortunately, while Gregory discusses both theories repeatedly, he presents no adequate analysis of either; and only after the reader has followed with increasing perplexity through a maze of contradictory arguments does he finally discover that the author's conceptions as to what are implied by the glacial and tectonic theories often differ radically from the generally accepted views. In order that we may properly appreciate the author's treatment of this important matter, let us summarize hastily some of the essential elements of each theory.

According to the glacial theory, fiords are partially submerged glacial troughs. The troughs of glaciated mountains far from the sea are similar to fiords, except that the former have not been drowned by marine waters. In both cases the troughs were formed by extensive glacial over-deepening of former river valleys. The preglacial valleys guided the glaciers which later came to occupy them, and by confining the ice streams to the narrow limits imposed by the valley walls insured a maximum efficiency of glacial erosion. The glacial theory asks no questions as to what determined the courses of the preglacial valleys; but it is fully recognized that among other causes ancient fault lines must be considered, since a fault may give a crushed zone which is weaker than the unfractured rock, or may bring a belt of weak rock into such position that subsequent valleys will soon be excavated along it, and hence parallel to the fault.

According to the tectonic theory, on the other hand, fiords are directly due to forces within the earth which cause a pronounced local and recent deformation of the earth's surface. This deformation may be in the nature of a gaping fissure where the rocks have parted along a fault or joint plane; or it may consist of a rift valley or graben caused by the down-dropping of a narrow strip of the earth's crust between two parallel faults. Such depressions may later be modified by river or glacial action; but the essential features of fiord topography must have existed prior to such modification. And whereas, according to the glacial theory, many fiords may be located along fault lines or joints, according to the tectonic theory *every* fiord must be so located.

Without pursuing this contrast further, let us turn again to Gregory's treatment of the problem. His misconceptions of the glacial theory are at once apparent. We have seen that this theory involves the recognition of preglacial river valleys which determined the courses of the more recent ice streams. Yet Gregory devotes a large amount of space to arguing that the valleys existed before the ice came, under the erroneous impression that this is incompatible with the glacial theory. In chapter after chapter this remarkable position is vigorously maintained. Indeed, he tells us that "The most conclusive argument against the glacial origin of the fiords is the preglacial age of their valleys; and it appears

to be admitted for practically all fiord-areas that the valleys are preglacial" (451). "The most fatal objection to the glacial origin of the fiords is the preglacial age of their valleys" (263).

It also follows from the glacial theory that the ice streams, being compelled to coincide in direction with the preglacial valleys, must often pursue courses which make large angles with the general direction of ice advance. Yet our author in combating the glacial theory lays much emphasis upon the fact that fiords are not always parallel to the general movement of the ice. "The distribution and arrangement of these Alaskan and British Columbian fiords is quite inconsistent with the theory of their glacial origin. The development of the fiords appears quite independent of the glaciation of the country; the direction of the fiords is not simply radial from the chief glacial centers" (317–18). "The direction of the ice-movement, however, did not fully agree with the trend of the fiords" (140). "Most fiord countries supply abundant instances of the fiords and the ice-movements having different directions" (451).

A still more serious misapprehension is entertained by the author as to the significance of the oft-observed coincidence between fiords and fault lines. As already noted, the glacial theory of fiord origin fully recognizes the fact that the preglacial valleys, later transformed into fiords, were often excavated along ancient fault lines. To prove the presence of a fault-line through a fiord is therefore to prove nothing as to the glacial or tectonic origin of that fiord. But Gregory is not of this opinion. A very large proportion of his argument against the glacial theory consists simply in showing that faults are associated with fiords. Indeed, he is often content to show that *some* fiords in a region are traversed by faults; or even that faults are known which trend parallel with the fiords of a given region; and on such a basis concludes in favor of the tectonic theory of fiord origin. Often he goes so far as to admit that the fiord-valley was not formed by crustal deformation, but by stream erosion along a crushed or weak rock zone; yet he cites even such cases in support of the tectonic theory, entirely ignoring the all-important distinction between valleys produced by erosion along ancient fault lines, and depressions due to deformation along recent fault lines. The fiords of western Iceland are described as "connected with a series of fractures" (141) while "Faults are numerous around the Greenland coast, and in many cases they coincide with the fiords" (265). "The evidence for these faults (in Alaska) is often obscured, and along the fiords such faults could hardly be recognized; but their recognition by Messrs. Moffit and Capps in the Nizina district renders it probable that intersecting faults may be widely distributed through Alaska, and form planes of weakness along which the fiords have been excavated" (322–23). "The tectonic origin of the (New Zealand) fiords has been recently advocated by Speight. He accepts Andrews' view that they are old river valleys modified by glaciation, but he recognizes that the original course of the valleys was dependent on lines of fracture in the earth's crust" (365). The most pronounced glacialist would accept much of Gregory's lengthy argument against the glacial theory, as a statement of conditions normally to be expected on the basis of that theory.

A careful study of the author's ideas concerning tectonic valleys in the hope of finding some explanation for the apparent lack of consistency in his arguments, only increases one's perplexity. On page 394 we read: "Some valley systems are due to the folding of the earth's crust, which has raised soft bands to the surface, where they are worn into valleys, while the harder rocks resist and remain as ridges. The faulting of the earth's crust also produces bands of weak and shattered rocks which are easily washed away, and thus many valleys have been worn out along fault lines. Joints have a somewhat similar effect. . . . Such valleys, though their directions have been determined by earth movements, are valleys of excavation. Tectonic valleys, on the other hand, are the direct results of the earth-movements themselves." This is a clear

statement of the generally accepted distinction between erosion valleys guided by structure, and tectonic valleys; but it is directly contradicted by the major portion of the author's arguments on the preceding 300 pages of the book. The contradiction is even more amazing when we compare this statement with one on page 455, where tectonic valleys are divided into several groups and one group is defined as follows: "Valleys formed along fault-planes owing to the removal by denudation of a belt of rocks which has been crushed by earth-movements." It is clear that the author's ideas as to what constitutes a tectonic valley, the most vital point in his entire book, were confused and contradictory, and varied from time to time as he wrote. Similar contradictions regarding other matters appear so frequently throughout the book that it is often quite impossible to know what opinion the author really holds regarding essential points in the problem he discusses.

Throughout the book much reliance is placed on *authority,* and hundreds of quotations favorable to the tectonic theory are adduced to strengthen the case for that theory. Many of these quotations date back to a time when the knowledge of land forms was in its infancy; others are from writers unqualified to speak authoritatively on the interpretation of land forms; and occasionally the author quoted wrote in a poetic or figurative sense. In the chapter on Alaskan fiords Gregory writes: "The explanation of these fiords as simply due to glacier corrosion seems to me quite inadequate. That they are due to the action of some tectonic force has been recognized by many visitors to them. Mr. John Burroughs has graphically expressed this view." Then follows this quotation from Mr. Burroughs: "The edge of this part of the continent for a thousand miles has been broken into fragments, small and great, as by the stroke of some earth-cracking hammer, and into the openings and channels thus formed the sea flows freely, often at a depth of from one to two thousand feet." The fact that Mr. Burroughs is not a geologist, and is therefore presumably unacquainted with Alaskan geology, did not deter Gregory from citing this bit of imagery as a substantial confirmation of his theory. Views unfavorable to the tectonic theory are also quoted at length, but are quickly dismissed as untenable. Favorable views are as quickly accepted. In neither case is there any serious attempt to present the quoted author's evidence, review his line of argument, and then subject his conclusions to critical analysis before accepting or rejecting them.

Another reason for accepting Gregory's work with reserve is found in his frequent misinterpretation of the views entertained by authors from whom he quotes. His own belief in the tectonic theory was so strong that he unconsciously read into the works of others ideas favorable to his theory which they did not express. Of the many instances of this I will cite but a few. On page 309 Gregory refers to the work of Tarr and Martin on the Yakutat Bay earthquake, and while he acknowledges that these authors recognized but one fault along Russell fiord, and attributed the present depth and form of the fiords to glacial erosion, he goes on to say that "the shores of this fiord appear to lie along two old faults, the prolongation of which formed the valley occupied by the Hidden Glacier, and movements along the two faults would explain the facts as well as along one fault. This earthquake illustrates how fiord valleys have been formed by parallel trough-faults. . . . Tarr and Martin's memoir shows that the formation of fiord-valleys by trough faulting is still in progress in Alaska." After reading this, one unfamiliar with the memoir in question will be surprised to find that Tarr and Martin considered the faulting hypothesis of origin for these fiords at length, adduced a variety of evidence opposed to this theory, and concluded by showing that it was quite impossible to explain the fiords as a product of faulting. According to Martin the stratigraphic evidence positively proves the absence of two parallel faults. In support of his position Gregory says that in a later memoir Tarr "attached less importance to glacial action" in the formation of fiords.

On the contrary, the memoir cited is a most vigorous argument in favor of the glacial theory of fiord formation. In it Tarr writes: "Of all the hypotheses proposed, glacial erosion alone appears capable of explaining all the facts. . . . The facts set forth in this chapter prove conclusively that ice has eroded in this inlet to a remarkable degree. . . . Those who oppose vigorous glacial erosion are in the position of those who opposed river erosion long after the majority of workers accepted it—that of ultra-conservatism." [2]

Gregory cites Mendenhall's discussion of differential warping in the Cook Inlet region of Alaska, and continues: "These two fiords, therefore, according to Mendenhall, occur along a depression due to earth-movements, and the same explanation offers the simplest interpretation of many other Alaskan fiords and fiord-straits. They appear to be of tectonic rather than of glacial origin" (324). But Mendenhall's report conveys a very different idea.[3] He shows that normal river valleys were occupied by glaciers which "greatly modified" them, and that then these glacially modified valleys were submerged by a depression of the land. Only later, after the fiords had already been in existence for some time, began the differential warping cited by Gregory. As this was an unequal *uplift,* it tended to *destroy* fiords by raising them above the sea-level, not to make them. It is difficult to understand how even an enthusiast for the tectonic theory could find in this faint differential uplift an argument for the tectonic origin of the deep-cut Alaskan fiords. The same might be said of the author's appeal to the differential uplift of the Labrador Coast, as described by Daly, as an explanation for the rock basins and thresholds of Labrador fiords (283); for it is impossible to see how the slight warping of a little more than one foot per mile described by Daly, could account for the reversed slopes of more than 250 feet per mile in the fiords.

Spurr is also quoted in support of the tectonic origin of Alaskan fiords. Gregory writes: "According to Spurr the lake-basins are preglacial. He says that 'all the lakes of southwestern Alaska, so far as observed by the writer, occupy mountain-valleys which are evidently the ancient river-valleys of the late Miocene'" (319). This quotation from Spurr says nothing at all about the preglacial age of the lake basins. The preglacial age of the valleys alone is indicated; and the context from which this quotation was taken makes it quite clear that the lakes, and consequently their basins, are of more recent date.[4]

Gregory's interpretations of his field observations do not always carry conviction. Photographs and sketches of typical glacial troughs with well-developed catenary curves are described as "V-shaped valleys" and "normal denudation curves," apparently because slight bendings of a trough cause the distant profile of one trough wall to intersect the foreground of the opposite wall (Plate V., Figs. 73*d,* 73*e*). It is truly remarkable that such a drawing as Fig. 73*d* could be cited by any one as a "V-shaped valley"; but even more remarkable is the author's attempt to show that the well-known contrast between the forms of glaciated and non-glaciated valleys does not exist (425–32). Although the author has traveled widely, he "can not remember to have seen any considerable mountain-chain or mountain-area in any non-glaciated district which does not show truncated spurs, spurless walls and hanging valleys" (447). The supposed tectonic origin of Cattaro Bay, one of the Dalmatian "fiords," is illustrated by a beautiful photograph of the bay, in which what appear to be triangular "flat-irons" or hogbacks formed by resistant layers in the folded beds, are described as "triangular facets due to faulting" (Plate VI.).

Many readers will hesitate to accept Gregory's arguments because of the significant

[2] R. S. Tarr, "The Yakutat Bay Region, Alaska," U. S. G. S., Professional Paper 64, p. 118, 1909.

[3] W. C. Mendenhall, "A Reconnaissance from Resurrection Bay to the Tana River, Alaska, in 1898," U. S. G. S., 20th Annual Report, Pt. VII., 332–34, 1900.

[4] J. E. Spurr, "A Reconnaissance in Southwestern Alaska in 1898," U. S. G. S., 20th Ann. Rept., Pt. VII., p. 258, 1900.

omissions which characterize the text. Against many of the arguments made by the author, other writers had previously raised very serious objections. We look in vain for any answer to many of these objections, or even mention of them. In the chapter on Dalmatian fiords, there is no intimation of the fact that a normally dissected belt of folded mountains, partially submerged (which is the type of topography found in this region) will necessarily have the long, narrow bays, the steep sided, spurless valley walls, and the short cross-valleys which the author erroneously correlates with those features in fiord districts often described in the same terms, but which really present a distinctly different topographic aspect. The fact noted by the author (202) that one of these drowned valleys has been called a "fiord" in Baedeker's guide book, can not be regarded as very significant. In support of the tectonic theory the author states that the Dalmatian valleys are not arranged like the members of ordinary river systems, as in Dalmatia the branchings and bendings are usually rectangular (207). He does not recognize that in all folded mountain regions involving rock layers of different resistance, the ordinary river valleys normally have this rectangular or "trellised" pattern. His arguments for the tectonic origin of the submerged Dalmatian valleys would apply with precisely as much force to the valleys of the folded Appalachians, the Juras and other similar dissected folds. The short cross valleys are not recognized as a normal product of river erosion across a narrow ridge of hard rock, but are interpreted in accordance with that ancient theory, long ago abandoned by most geologists, which explained the cross valleys as short cracks formed by bending brittle material. The substantial reasons which led geologists to abandon this theory as untenable are not referred to by the author.

It would be easy to multiply indefinitely examples of the unsound reasoning which seems to the reviewer to deprive the book before us of most of its value. The instances I have cited are not isolated examples which might be explained as the result of careless writing, but are typical of the book, as a whole, and must fairly represent the author's mental attitude toward the problem of fiord formation. It seems to the reviewer, therefore, that Gregory's attempt to rehabilitate a discarded theory of fiord formation must be considered a failure.

DOUGLAS W. JOHNSON

SPECIAL ARTICLES

THE IMPORTANCE OF A CONSIDERATION OF THE FIBER PROTEINS IN THE PROCESS OF BLEACHING COTTON

THE nitrogen which is found in the ripe cotton fiber seems to have some bearing upon the yellowing of bleached cotton cloth, as was pointed out by J. C. Hebden in his paper read in Troy before the American Institute of Chemical Engineers.[1] He showed that in the process of bleaching cotton cloth after the first caustic boil 91.5 per cent. of the proteins were removed from the fiber, whereas of the fats and waxes only 20.4 per cent. were removed; and after the second caustic boil 91.7 per cent. of the proteins and only 64 per cent. of the fats and waxes were eliminated; the "chemick" and the "sour" together, he showed, removed 12.05 per cent. of the remaining protein impurities and 10.23 per cent. of the remaining fats and waxes. According to his analysis, after all the bleaching operations there were still left on the fiber 30.4 per cent. of the total fatty and waxy impurities, whereas of the total proteins there were left only 7.3 per cent., and as the cloth which he analyzed had undergone a "good bleach," he felt safe in inferring that it is the failure to remove the protein impurities from the cotton that results in a "bad bleach" or causes the yellowing of cloth in steaming or during storage.

So far as we know, the investigator above referred to was the first to point out the possibility that the proteins of the fiber played such a part in the bleaching of the cloth. Previous to this it has been believed that the fatty and waxy matters and especially the

[1] *Journal of Industrial and Engineering Chemistry,* September, 1914, Volume 6, No. 9, page 714.

pectins were chiefly responsible for the yellowing of the fiber, since they formed water insoluble compounds, which remained on the fiber. The analysis of Hebden, however, showed that the calcium fixed on the fiber in the form of calcium salts was decomposed by the following acid treatments, and he explained the presence of the calcium on the fiber after the sour by the formation of a calcium cellulose similar to that of soda cellulose. The possibility of the formation of such a cellulose, he believed, was supported by the fact that cotton cloth which has been boiled and bleached did not produce as clear and as brilliant a turkey-red as cloth which had been simply boiled, because the former was not in a condition to fix calcium.

As the result of investigation in this line on cloth from different bleacheries, it occurred to us that an analysis of the growing cotton fiber with a view of determining the nitrogen and the fat and wax factors might reveal some points of importance. The determinations were carried out on Durango cotton raised on the United States Experiment Farm, San Antonio, Texas.[2]

The nitrogen factors were determined by the Kjeldhal-Gunning method, and the fat and wax factors by extracting samples of the fibers first by ether and then by alcohol. Some of the experiments were carried out in duplicates and some in triplicates, and the averages of the determinations were recorded as the final results. The figures given in the table below can only be regarded as approximating the absolute values of the nitrogenous and fatty and waxy constituents of the fiber; for the determination of exact values a much larger number of experiments should be performed. Nevertheless, they show the tendencies of the two factors and have, therefore, significance. The nitrogen determinations were made and recorded beginnings from the 14–16-day stage up to the 36–38-day stage, whereas the ether and the alcohol extracts were recorded only beginning with the 22–24-day stage, because in the stages previous to this the amount of tannins extracted by both ether and alcohol were much higher than the fats and waxes.

Age in Days from Flowering	Nitrogen in Per Cent.	Protein N. × 6.25	Alcohol Extr. in Per Cent.	Ether Extr. in Per Cent.	Fat and Wax in Per Cent.
14–16	2.2300	13.938	....	....	....
16–18	1.9480	12.175	....	....	....
18–20	1.4250	8.907	....	....	....
20–22	1.1820	7.388	....	....	....
22–24	....	....	4.405	2.819	7.225
24–26	.3760	2.350	1.745	.775	2.418
26–28	.3195	1.997	1.398	.713	2.111
28–30	.3123	1.952	1.415	.800	2.215
30–32	.2657	1.661	1.522	.782	2.304
32–34	.2590	1.619	1.536	.709	2.245
34–36	.2503	1.564	1.403	.802	2.205
36–38	.1815	1.134	1.409	791	2.200

From the above table it may be seen that the fats and waxes showed neither a gradual increase nor a gradual decrease in their percentages, and in view of the fact that the fiber was growing, it seems reasonable to suppose that the fatty and waxy substances increased proportionally as did the fiber. We believe that were the numbers of the experiments large enough to give averages approximating the absolute values of the fatty and waxy factors, this point would have been brought out much clearer. But even from the determinations which we can report, it appears that the fats and waxes extended in an even and constant thickness over the fiber. If we accept the view that the function of these substances is to protect the fiber from external influences of weather and disease, that is that they are merely external coats of the fiber, the significance of such a proportional growth of these constituents becomes clear. If, however, the fats and waxes are phosphotides taking part in the growth, there would also be a proportional increase. The nitrogen figures, on the other hand, show gradual decrease in percentage with the increase of the age of the fiber. The sudden increase of the factor at the 20–22-day stage as compared with that of the 24–26-day stage may be due either to a rapid growth of the nitrogenous constituents of the fiber or to the adhering nitrogenous coloring matters of the parts of the boll which surrounded the

[2] We wish to thank Mr. Rowland D. Mead, of the United States Department of Agriculture, for supplying us with the necessary samples of the cotton fibers.

fibers. If we limit ourselves to a consideration of the nitrogen figures of the samples representing only the higher stages of development of the cotton fiber even then we are permitted to assume that the nitrogen was deposited early in the lumen of the fiber and its absolute value remained constant. This assumption becomes more plausible when the nitrogen figures are multiplied by 6.25 to express the percentage of proteins present in the fiber. Most of this early and constant protein deposit remains in the lumen in the form of insoluble albuminoids and in the form of alcohol soluble proteins; some of it is utilized by the growing fiber, probably by the spiral forming the walls of the lumen. That the proteins of the fiber are of an insoluble nature is shown by the fact that the percentage of nitrogen of gray cloth as obtained by Hebden (0.191 per cent.) remained practically unchanged after the "steep" (0.192 per cent.), and that some of it exists in the fiber in the form of alcohol soluble proteins, is shown by the number which he obtained for nitrogen after extracting the cloth by ether and alcohol. The percentage, as shown in his table, was reduced from 0.191 per cent. to 0.161 per cent. The fact that the first caustic boil removed 91.5 per cent. of the protein content clearly points to the decomposing action of boiling alkali upon the albuminoids.

The 7.3 per cent. of total protein content remaining in the fiber after all the operations of the bleaching process can be considered as that part of the fiber proteins which has become an inseparable part of the wall of the lumen. The lowest percentage for fats and waxes (2.200 per cent.) obtained by us for the fiber taken directly from the field was considerable higher than that obtained by Hebden for fibers which were ginned, carded, spun and woven (1.405 per cent.). The removal of a large part of the fats and waxes by mechanical means during ginning, carding, spinning and weaving proves that these constituents form the outside cover of the fiber, and it is reasonable to suppose, therefore, that they do not play as important a part in bleaching as is ascribed to them. The percentage of nitrogen in our experiment (0.1815 per cent.) was somewhat smaller than that obtained by Hebden for cotton in the form of cloth (0.191 per cent.) and points to the fact that, unlike the fats and waxes, the proteins of the fiber are not adventitious nor coating factors, but that they are within the lumen or are in part intimately bound to the fiber. As the proteins are of the insoluble kind, the above seems to justify the assumption of Hebden that in bleaching the removal of the proteins may be of more importance than that of the fats and waxes.

These results and the results of Hebden show the necessity of a careful investigation of the chemical nature of the fatty and waxy substance as well as of a further study of the effect of growth on these constituents of the cotton fiber.

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THE AMERICAN PHYTOPATHOLOGICAL SOCIETY

THE sixth annual meeting of the American Phytopathological Society was held in the medical building of the University of Pennsylvania, Philadelphia, Pennsylvania, December 29, 1914, to January 1, 1915. About 95 members were present; 7 new members were elected, making a total of 293. The following officers were elected for 1915:

President—H. H. Whetzel.

Vice-president—W. A. Orton.

Councilor—Mel. T. Cook.

Donald Reddick was elected editor for three years and made chairman of the board. The following associate editors were elected for three years: H. W. Barre, E. A. Bessey, H. R. Fulton, W. T. Horne.

C. L. Shear was elected business manager vice Donald Reddick.

The society decided to hold its next annual meeting at Columbus, Ohio, in connection with the American Association for the Advancement of Science.

A special meeting is to be held at San Francisco, August 2 to 7.

The committee on common names of plant diseases submitted a report which was ordered distributed to the members of the society for suggestion and criticism.

The society instructed the secretary to select two other persons, as required by law, and proceed to incorporate the society under the laws of the District of Columbia.

The society received greetings by telegraph from the newly organized Western Branch meeting at Corvallis, Oregon. The following resolution was adopted by the society:

"The council recommends that the society extend cordial greetings to the newly organized Western Branch of the American Phytopathological Society, and also recommends that a committee consisting of the present president, Haven Metcalf, and the secretary, with power to increase their number to five, be authorized to formulate the necessary terms of affiliation to provide for this and other future branches which may be organized."

The following constitutional amendment proposed at the last meeting was adopted:

Article 3, section 3, shall be changed to read: "Any person may become a patron upon the payment of $100."

The method of presenting papers by abstract introduced at the Atlanta meeting was continued, with slight modifications, with much success. Six minutes were allowed for the presentation of each paper, the author being permitted to read the abstract as printed, or use the allotted time in giving additional explanations or presentation of the topic, after which five minutes were allowed for discussion. The same method of handling the program was adopted for the future and the secretary authorized to limit the time for the acceptance of titles and abstracts to December 1, in order that they might be published in the December issue of *Phytopathology*.

The following resolution in regard to the *Urophlyctis* disease of alfalfa was adopted:

WHEREAS, The plant pathologists or other officials of the individual states are unable properly to meet the situation, partly from lack of information, partly because it is essentially on international and interstate problem, be it therefore

Resolved, That we respectfully invite the attention of the Honorable Secretary of Agriculture and other officials of the U. S. Department of Agriculture to the above facts and urge the importance of immediate earnest investigation under their leadership as to the present occurrence and seriousness of the disease, as to its means of distribution and as to what steps, if any, should be taken to check its further spread.

The society passed a unanimous vote of thanks to the local committee for the excellent facilities and courtesies offered the society during the meeting, and to Dr. F. D. Heald for the care of the exhibits and other assistance in promoting the success of the meeting; also to the chair for conducting the meeting with promptness and carrying the program through on time.

The following program of 58 papers was presented:

Tuesday, Joint Session with Section G, American Association

Meeting of the council and board of editors, Hotel Walton.

December 30, 1914

"The *Verticillium* Wilt Problem," by C. W. Carpenter.

"Orchard Experiments in 1914," by Mel. T. Cook and G. W. Martin.

"A Nursery Disease of the Peach," by Mel. T. Cook and C. A. Schwarze.

"A Method for Excluding Mites from Pure Cultures," by C. W. Carpenter.

"Studies of the genus *Phytophthora*," by J. Rosenbaum.

"A Bacterial Leaf Spot Disease of Celery," by Ivan C. Jagger.

"The Spindling Sprout Disease of Potatoes," by F. C. Stewart.

"Thrombotic Disease of Maple," by W. H. Rankin.

"Mutation in *Phyllosticta*," by C. Harvey Crabill.

"A *Nectria* Parasitic on Norway Maple," by Mel. T. Cook.

"An Unreported Fungus on the Oak," by C. A. Schwarze.

"The Use of Sulphur for the Control of Potato Scab," by H. Clay Lint.

"*Citrus* Canker," by A. B. Massey.

"The *Citrus* Canker Situation," by R. Kent Beattie.

Meeting with the Botanical Society of America

Symposium: Genetic relationship of organisms.

December 31, 1914

"Leaf-spot and Some Fruit Rots of Peanut," by Frederick A. Wolf.

"Hosts of Brown-rot *Sclerotinia*," by J. B. S. Norton.

"Resistance to *Cladosporium fulvum* in Tomato Varieties," by J. B. S. Norton.

"Loss from Mosaic Disease of Tomato," by J. B. S. Norton.

"Notes on Soil Disinfection," by Carl Hartley.

"A Wilt Disease of Japanese and Hybrid Plums," by B. B. Higgins.

"The Perfect Stage of *Phyllosticta paviae* Desm," by V. B. Stewart.

"Studies on *Plasmopora viticola*," by C. T. Gregory.

"A New Rust of Economic Importance on the Cultivated Snapdragon," by Geo. L. Peltier and C. C. Rees.

"The Relation between *Puccinia graminis* and

Host Plants Immune to its Attack," by E. C. Stakman.

"Further Studies on the Spread and Control of Hop Mildew," F. M. Blodgett.

"The Longevity of Pycnospores and Ascospores of *Endothia parasitica* under artificial conditions," by F. D. Heald and R. A. Studhalter.

"Field Studies of Apple Rust," by N. J. Giddings and Anthony Berg.

"Cotyledon Infection of Cabbage Seedlings by the Bacterial Black Rot," by Charles Drechsler.

"Fungus Host Relationship in Black Knot" (with lantern). by E. M. Gilbert.

"Stigmonose: A Disease of Fruits," by M. B. Waite.

"Jonathan Spot, Bitter Pit and Stigmonose" (with lantern), by Charles Brooks and D. F. Fisher.

"The Organization of the Plant Disease Survey," by R. Kent Beattie.

"Some Technical Aids for the Anatomical Study of Decaying Wood" (with lantern). by E. W. Sinnott and I. W. Bailey.

"Apple Rots" (with lantern), by Charles Brooks, D. F. Fisher and J. S. Cooley.

"The Relation of Temperature to the Infection of Cabbage by *Fusarium conglutinans* Wollenw," by J. C. Gilman.

"Third Progress Report on Fusarium Resistant Cabbage" (with lantern), by L. R. Jones.

"York Spot and York Skin Crack" (with lantern), by H. S. Reed.

"Soil Stain and Pox, Two Little-known Diseases of the Sweet Potato" (with lantern), by J. J. Taubenhaus.

"*Rhizoctonia* in America" (with lantern), by Geo. L. Peltier.

"Lightning Injury to Cotton and Potato Plants," by L. R. Jones and W. W. Gilbert.

"Orchard Experiment with Jonathan Spot Rot in 1914," by G. W. Martin.

"The Perfect Stage of the Fungus of Raspberry Anthracnose," by W. H. Burkholder.

January 1, 1915, Business Meeting

"Parasitism, Biology and Cytology of *Eocronartium typhuloides* Atk.," by Harry M. Fitzpatrick.

"Negative Heliotropism of the Urediniospore Germ Tubes of *Puccinia rhamni*," by F. D. Fromme.

"The Ascigerous Stage of *Helminthosporium teres* Sacc.," by A. G. Johnson.

"A Gymnosporangium with Repeating Spores," by J. C. Arthur.

"A Preliminary Report on Twig and Leaf Infection of the Peach by Means of Inoculations with *Cladosporium carpophilum* Thüm," by G. W. Keitt.

"Notes on *Cronartium comptoniae* and *C. ribicola*," by Perley Spaulding.

"How to Know the Polypores," by W. A. Murrill.

"Some Problems of Plant Pathology in Reference to Transportation," by F. L. Stevens.

"A Disease of Red Clover and Alsike Clover Caused by a New Species of Colletotrichum," by P. J. O'Gara.

"An Anthracnose of *Asclepias speciosa* Caused by a New Species of Colletotrichum," by P. J. O'Gara.

"A Disease of the Underground Stems of Irish Potato Caused by a New Species of *Colletotrichum*," by P. J. O'Gara.

"A Preliminary Report on the Relation of Grass Rusts to the Cereal Rust Problem," by E. C. Stakman.

"Some Facts of the Life History of *Ustilago zeae* (Beckm.) Unger," by Frank J. Piemeisel.

"A Promising New Fungicide," by W. M. Scott.

"The Potato Study Trip of 1914," by W. A. Orton.

"Some Effects on Chestnut Trees of the Injection of Chemicals" (with lantern), by Caroline Rumbold.

C. L. SHEAR,
Secretary-Treasurer

THE PHILADELPHIA MEETING OF THE AMERICAN PSYCHOLOGICAL ASSOCIATION

THE twenty-third annual meeting of the American Psychological Association was held on December 29, 30 and 31, 1914, in affiliation with the American Association for the Advancement of Science and the Southern Society for Philosophy and Psychology at the University of Pennsylvania, Philadelphia. Professor Robert Sessions Woodworth, of Columbia University, presided.

As president of the association for the ensuing year, Professor John B. Watson, of the Johns Hopkins University, was selected. As members of the council, to succeed Professors Max Meyer and Margaret F. Washburn, Professors Roswell P. Angier, of Yale University, and Walter Dill Scott, of Northwestern University, were chosen. The association's representative upon the council of the American Association for the Advancement of Science will be Dr. Thomas H. Haines, of Columbus, Ohio.

It was decided to hold a special meeting for the reading of papers at San Francisco, in affiliation with the American Association for the Advancement of Science. The dates of this meeting will fall within the time selected by the larger association, August 2–7, 1915. The organization of this special meeting, and all arrangements pertaining to the program, etc., was left in the hands of a committee appointed by the president. This committee consists of Professor G. M. Stratton, University of California, chairman, and Professors Lillien J. Martin and Warner Brown. The place of the twenty-fourth annual meeting, to be held as usual during Convocation Week of 1915, was left

to the decision of the Council, and will be determined shortly.

A special feature of the business session which aroused much interest and discussion was the report of the Committee on the Academic Status of Psychology. This committee, made up of Professor H. C. Warren, Princeton University, chairman, and Professors John Dewey and Charles H. Judd, presented a comprehensive report in printed form, based upon data secured from 165 colleges and universities. The results indicated, among other things, that psychology is still constrained in many institutions to furnish the foundation for work in philosophy and education, and thus lacks the autonomy requisite in developing its own special interests and problems. Three resolutions offered by the committee were adopted by the association: (1) That a standing committee be appointed to continue the work here begun. (2) that a topic bearing upon the teaching of psychology be chosen for discussion at the next annual meeting. (3) That the association adopt the principle that the undergraduate psychological curriculum in every college or university great or small, should be planned from the standpoint of psychology, and in accordance with psychological ideals, rather than to fit the needs and meet the demands of some other branch of learning.

The program of the association included the reading of some forty-five papers. Joint sessions were held with Section L of the American Association for the Advancement of Science, and with the Southern Society for Philosophy and Psychology. As a whole, the program was notable for the evident interest of the participants in the pursuit of introspective psychology under experimental conditions. The keynote was struck by President Woodworth in his address, "A Revision of Imageless Thought," in the course of which an interesting theory of "mental reaction" was propounded to account for certain non-sensory contents of consciousness as revealed by introspective studies. Another feature was the discussion with demonstration of the introspective method, as conducted by Professor J. W. Baird, of Clark University, with the assistance of several of his former students and colleagues.

The papers read were as follows:

"Habit Formation and Modern Language Teaching," by Stuart H. Rowe.

"Initial Speed and Total Gain in Learning," by E. A. Kirkpatrick.

"Notes on Certain Phases of Learning," by S. S. Colvin.

"Some Learning Curves," by M. E. Haggerty.

"Some Norms of College Freshmen," by W. V. Bingham.

"A Study in Mental Retardation in Relation to Etiology," by Bird T. Baldwin.

"A Method for Qualitative Study of Family Likeness in Arithmetical Abilities," by Margaret V. Cobb.

"Effect of Heat, Humidity and Stagnancy of Air upon Mental Work," by E. L. Thorndike.

"Notes on Affective Physiology," by George V. N. Dearborn.

"Variations in Distribution of the Motor Centers of the Monkey Brain," by S. I. Franz.

"Some Relations of Mania to the Sensorium," by E. E. Southard.

"Some Cases of Paramnesia," by Nathan A. Harvey.

"Some Technical Results from the Alcohol Program," by Raymond Dodge.

"An Apparatus for Testing Visual Sensitivity to Contrast in Animals," by H. M. Johnson.

"Apparatus for Serial Exposure in Memory Experiments," by E. H. Cameron.

"Model Animal Maze," by C. Homer Bean.

"Tactimeter," by C. Homer Bean.

"Puzzle Box for Illustrating Problem-Solving Learning, and for Testing Mechanical Ability; a Form of Mirror-Drawing Apparatus which allows Modification of the Movement-Stimulus Relation; Mirror Frame for Observing Eye-Movements," by Frank N. Freeman.

"Tachistoscope," by F. C. Dockeray.

"A Self-recording Hand Dynamometer," by Henry C. McComas.

"Pictures and Class Experiments," by E. A. Kirkpatrick.

"A Proposed Classification of Mental Functions," by George A. Coe.

"The Temporal Relations of Meaning and Imagery," by Thomas V. Moore.

"Psychology of Slavic People," by Paul R. Radosavijevich.

"The Craving for the Supernatural," by Tom A. Williams.

"The Study of Dreams: A Method Adapted to the Seminary," by Madison Bentley.

"Concerning the Religion of Childhood," by W. T. Shepherd.

"The Point Scale Method of Measuring Mental Ability," R. M. Yerkes.

"The Point Scale Rating of Delinquents," by Thomas H. Haines.

"Correlations between the Binet Tests and other Mental and Physical Tests," by Edward K. Strong, Jr.

"Norms of Negro Mentality," by W. H. Pyle.

"The Standardization of Knox's Cube and Feature Profile Tests," by Rudolf Pintner.

"On the Memory for Musical Sequences," by Kate Gordon.

"Effects of Practise on the Singing and Discrimination of Tones," by E. H. Cameron.

"The Vowel Character of Fork Tones," by A. P. Weiss.

"The Influence of Expectation on Sound Localization," by L. R. Geissler.

"Individual Differences in Fluctuations of the Attention," by Henry C. McComas.

"Awareness and Partial Awareness as Factors in Efficiency," by G. F. Arps.

"The Acquisition of Skill in Archery," by K. S. Lashley.

"A New Method of Studying Ideational and Allied Forms of Behavior in Man and other Animals," by R. M. Yerkes.

"A Preliminary Report on Number Reactions in the Dog," by A. H. Sutherland.

"The Visual Difference-Threshold for Size in the Monkey and the Domestic Chick," by H. M. Johnson.

"Two Cases of Criminal Imbecility," by Henry H. Goddard.

"The Value of Anthropometric Measurements in the Diagnosis of Feeblemindedness," by E. A. Doll.

"The Influence of Improvement in one Simple Mental Process upon Other Related Processes," by A. T. Poffenberger, Jr.

"A Revision of Imageless Thought," address of the president, by Robert Sessions Woodworth.

"The Introspective Method, with Demonstrations," by J. W. Baird.

"A Preliminary Report of an Introspective Study of the Process of Comparing," by Samuel W. Fernberger.

"An Experimental Investigation of the Process of Recognizing at Different Stages of its Mechanism," by Elizabeth L. Woods.

"An Experimental Study of Generalizing, Abstraction and the General Concept," by S. Carolyn Fisher.

"Determination of the Psychologically Unitary Color Sensations," by Christine Ladd-Franklin.

"External Localization in Memorizing Verbal Material," by Eleanor A. McC. Gamble.

"Affective Factors of Recall," by Garry C. Myers.

"An Experiment on Choice Reaction," by Prentice Reeves.

"The Function and Test of Definition and Method in Psychology," address of the retiring Vice-president of Section H, by Walter Bowers Pillsbury.

"Report of the Committee on the Academic Status of Psychology," by Howard C. Warren.

R. M. OGDEN,
Secretary

THE ILLINOIS ACADEMY OF SCIENCE

THE eighth annual meeting of the Illinois Academy of Science was held at the State Museum, Springfield, February 19 and 20. The Friday afternoon program consisted of four addresses: "The Chemistry of Colloids," Dr. D. A. MacInnes, University of Illinois; "Colloids in Physiology," Dr. William Crocker, University of Chicago; "Colloids in Commerce" (read by title), Dr. L. I. Shaw, Northwestern University; "Recent Developments in Surgery," Dr. Don W. Deal, Springfield.

In the evening the members of the academy were the guests of the Springfield Commercial Association at a banquet served at the Leland Hotel. Ex-Governor Northcott acted as toastmaster, and short addresses were made by Senator Kelly and Professor John M. Coulter.

The evening lecture was delivered by Dr. Day, director of the Carnegie Geophysical Laboratory, Washington, D. C., on "Volcanic Emanations."

The Saturday morning program included the following papers:

Section of Botany, Bacteriology and Chemistry

"Character of Water Used on Railway Trains," by Dr. Edward Bartow, University of Illinois.

"Comparison of Rocky Mountain Grassland with the Prairie of Illinois," by Dr. George D. Fuller.

"Studies in *Phyllosticta* and *Cercospora*," by Miss Esther Young.

"The Arsenic Content of Filter Alum Used in Illinois Water Purification Plants," by Mr. A. N. Bennett.

"Method of Determining the Life Duration of Seeds," by Mr. James F. Groves.

"Studies on *Schizophyllum alneum* in Respect to Cultures and Inoculations," by Mr. Alvah Peterson, University of Illinois.

"The Longevity of *B. Coli* and *B. Typhosus* in Water," by Mr. M. E. Hinds.

"Peculiar Examples of Plant Distribution," by Dr. H. S. Pepoon.

"Manganese in Illinois Water Supplies," by Mr. H. P. Corson.

"Some Features in the Classification of *Septoria* and *Parodiella*," by Mr. Philip Garman.

"Comparison of Methods of Determining Dissolved Oxygen in Water and Sewage," by Mr. F. W. Mohlman.

"The Grasses of Illinois," by Miss Edna Mosher.

"A Florida Smut in Illinois," by Miss Margaret Mehlkof.

"The Violets of Illinois," by Mr. Rufus Crane.

Section of Zoology, Entomology and Geology

"What California is Doing in the Control of Injurious Insects," by Miss Gertrude A. Bacon.

"The Labium of the Nymphs of Zygoptera," by Mr. Philip Garman.

"The Comparative Morphology of Some Carabid Larvæ," by Mr. Clyde C. Hamilton.

"The Loess in Illinois: Its Age and Origin," by Dr. T. E. Savage.

"Recent Crustal Movements in the Great Lakes Region," by Professor Charles E. Decker.

"A Restudy of Worthen's Type Section of the 'Productive Coal Measures' for Central and Western Illinois," by Dr. T. E. Savage.

"The Prothonotary Warbler," by Dr. W. S. Strode.

"Some Adaptations for Respiration in Aquatic Hemiptera," by Miss Anna G. Newell.

"Mouth Parts of the Blow-fly," by Mr. Alvah Peterson.

"Collecting Snail Shells," by Mr. James H. Ferris.

'The Morphology of Certain Sphinx Pupæ," by Miss Edna Mosher.

On Saturday afternoon addresses were delivered by Ex-Governor Northcott, and the retiring president, Dr. A. R. Crook, on "The Relation of Academies of Science to the State."

The officers elected for the coming year are:

President—Dr. U. S. Grant, Northwestern University, Evanston.

Vice-president—Dr. E. W. Washburn, University of Illinois, Urbana.

Secretary—Dr. A. R. Crook, State Museum, Springfield.

Treasurer—Dr. H. S. Pepoon, Lake View High School, Chicago.

The 1916 meeting will be held at the University of Illinois.

E. N. Transeau,
Secretary

SOCIETIES AND ACADEMIES

THE BOTANICAL SOCIETY OF WASHINGTON

The one hundred and second regular meeting of the Botanical Society of Washington was held in the Assembly Hall of the Cosmos Club at 8 P.M., on Tuesday, February 2, 1915. Fifty-two members and six guests were present. Dr. P. A. Yoder and Messrs. Stephen Anthony and James M. Shull were elected to membership. The following scientific program was presented:

Bamboo Possibilities in America: Mr. S. C. Stuntz.

After a brief introductory statement outlining the past history of bamboo introduction into the United States, and sketching the present condition of bamboo planting in this country, attention was directed to the possible future uses for bamboo. Furniture, basketry, especially for parcel post shipments, Venetian blinds and barrel hoops were suggested as probable industries in which bamboo would find use, while the development for ornamental planting and as a possible stock for paper was especially emphasized. Lantern slides of bamboo plantations and uses abroad and in the United States were shown, together with a considerable exhibit of manufactured bamboo articles.

Botany of Cacao and Patashte: Mr. O. F. Cook.

The patashte tree is a relative of the cacao, known to botanists under the name *Theobroma bicolor* Humboldt and Bonpland. It has dimorphic branches like cacao, the lateral branches being formed in whorls at the ends of the upright shoots, but only 3 laterals in a whorl, instead of 5 or 6, as in cacao. Many other differences in leaves, inflorescences and flowers were shown. The inflorescences of patashte are confined to new growth at the ends of the lateral branches, while cacao is caulocarpous, with all of the flowers produced from the old wood on the trunk and larger limbs of the tree. The various features were explained with lantern-slide illustrations, and the paper was followed by a brief discussion of the question whether trees with such numerous and definite differences should be classified in the same genus.

Rediscovery of Lignum nephriticum: Mr. W. E. Safford.

Lignum nephriticum is a remarkable Mexican wood which was celebrated throughout Europe in the sixteenth, seventeenth and the early part of the eighteenth centuries, not only for its reputed

medicinal properties, but on account of the wonderful fluorescence of its infusion in spring water. Scarcely a fragment of this wood is now to be found in drug collections, and its very name has disappeared from encyclopedias. It is celebrated as the substance with which the Hon. Robert Boyle made his first investigations in the phenomenon of fluorescence. After giving a history of the literature on the subject Mr. Safford called attention to the confusion surrounding the origin of the wood, and the causes which prevented its botanical identification. For the first time specimens of the wood accompanied by herbarium material of the plant from which it was obtained have been the subject of critical study. The heartwood produced the characteristic fluorescence described by Robert Boyle, and the botanical material corresponded with the original description of Hernandez of the plant yielding *lignum nephriticum*. This proves to be *Eysenhardtia polystachya* (Ortega) Sargent (*Viborquia polystachya* Ortega, *Eysenhardtia amorphoides* H. B. K.). The lecture was illustrated by lantern slides, specimens of the wood and botanical material, photographic enlargements of sections of the wood made by Dr. Albert Mann, plant morphologist; and also by exhibition of the fluorescence of the extract of the wood in the rays of an arc light by Dr. Lyman J. Briggs, Biophysicist, Bureau of Plant Industry, with remarks as to the value of *lignum nephriticum* as an indicator in titrimetric determinations.

THE one hundred and third regular meeting of the Botanical Society of Washington was held in the Crystal Dining Room of the New Ebbitt Hotel, at 6:45 P.M., Tuesday, March 2, 1915. Eighty-two members and seventy-eight guests were present, this being the regular annual open meeting for the president's address.

A dinner preceded the scientific program.

The retiring president, Dr. C. L. Shear, gave an address on "Mycology in Relation to Phytopathology." This appears in full elsewhere in SCIENCE.

Dr. A. S. Hitchcock presented to the society the plans for a proposed publication of a local flora on the flowering plants and higher cryptogams of Washington and the vicinity. It is proposed that this be published about one year from the present time.

The society also passed resolutions of regret upon the death of Dr. Charles E. Bessey.

PERLEY SPAULDING,
Corresponding Secretary

BIOLOGICAL SOCIETY OF WASHINGTON

THE 535th meeting of the society was held in the Assembly Hall of the Cosmos Club, Saturday, February 6, 1915, called to order by Vice-president Hopkins at 8 P.M., with 35 persons present.

Under heading Book Notices, Dr. Ransom called attention to a new biological journal under editorship of Professor Ward, of the University of Illinois, to be devoted to animal parasites.

Under heading Brief Notes, Treasurer Cooke read a letter from Dr. B. W. Evermann, now of San Francisco, a former president of the society, expressing his regret at not being able to attend meetings, his deep interest in the society, and wishes for its continued prosperity.

The first paper of the regular program was by Dr. T. Wayland Vaughan, "Remarks on the Rate of Growth of Stony Corals." Dr. Vaughan reviewed the work done by previous investigators and gave result of his own carefully conducted experiments at Tortugas. The paper was fully illustrated by lantern slides showing apparatus and methods employed in planting corals and results of one and of several years' growth of various corals.

The second paper of the regular program was by Dr. J. N. Rose, "Botanical Explorations in South America." Dr. Rose spoke concerning a botanical exploration on the west coast of South America which he made during the summer and fall of 1914. He stated that when he took up the study of the Cactaceæ for the Carnegie Institution of Washington, it was with the understanding that it should embrace not only herbarium and greenhouse studies, but extensive field work in all the great cactus deserts of the two Americas. His going to the west coast was therefore simply part of a large scheme for botanical exploration. He further stated that plans had been made for similar field work in the deserts of the east side of South America during the coming summer. He gave detailed accounts of his work in the deserts of Peru, Bolivia and Chile, and the peculiar Cacti which he found, described particularly the climatic conditions in those countries, and told of the remarkable crescent-shaped sand dunes of southern Peru. On this trip Dr. Rose collected more than a thousand numbers, obtaining not only herbarium and formalin, but also living material. His collection of living plants which was very large has been sent to the New York Botanical Garden. Dr. Rose's communication was illustrated by maps of the regions traversed, by apparatus used in collecting speci-

mens, and by preserved specimens. The paper was discussed by Messrs. Hitchcock, Vaughan, Goldman and Townsend.

The 536th meeting of the society was held in the Assembly Hall of the Cosmos Club, Saturday, February 20, 1915, called to order by President Bartsch at 8 P.M., with sixty-five persons present.

Dr. Charles Monroe Mansfield, of the Bureau of Animal Industry, on recommendation of the council, was elected to active membership.

Under the heading of Brief Notes, General Wilcox made observations and inquiries concerning the color of the eyes of certain turtles. His remarks were discussed by W. P. Hay. Dr. Howard described the successful campaign carried on against mosquitoes in New Jersey.

Under the heading Exhibition of Specimens, Wm. Palmer exhibited the tip of the tongue of a sulphurbottom whale and considered the probable use of its peculiar shape. Messrs. Bartsch, Hay and Lyon took part in the discussion.

The regular program consisted of an illustrated lecture by H. C. Oberholser, entitled, "A Naturalist in Nevada." Mr. Oberholser gave an account of a biological survey of parts of Nevada made by himself and others some years ago. He described the geologic, geographic and climatic characters of the route traversed by his party. He mentioned in particular the plants, the mammals, birds and reptiles observed and collected by the expedition; and pointed out how they were influenced in kind and numbers by the unusual geographic and climatic conditions found in Nevada. He showed many excellent views of the country and of the animals and plants encountered.

Mr. Oberholser's paper was discussed by Messrs. Hay, Bartsch, Bailey, Lyon, Goldman, Wetmore and Wm. Palmer.

M. W. Lyon, Jr.,
Recording Secretary

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

At a special meeting of the society, held November 3, 1914, at the public library, Dr. J. Walter Fewkes read a paper on "Vanished Races of the Caribbean." The aborigines who, in pre-Columbian times, inhabited the West Indies, represent a vanished race, for with the exception of very incomplete historical accounts and a few highly modified living survivors, archeological remains only are left from which to determine their culture. The Antillean culture belonged to the stone age, and while it had attained a considerable development, it was quite unlike that of any other area in the New World. These islands were peopled from the neighboring continent, but the peculiar types of stone objects which occur on the islands indicate that the culture they represent originated where it was found. This culture was of two types, one in the Greater Antilles and the other in the so-called Carib Islands. These differ mainly in the forms of stone implements, pottery and other artifacts. For instance, 90 per cent. of the stone implements of the Greater Antilles have the form of celts, while the majority of implements from the Lesser Antilles are axes. This difference in the culture was noticed by Columbus and the early chroniclers. The inhabitants of the Lesser Antilles were called Caribs, the others Arawaks. The Caribs were preceded by an agricultural people whom they conquered in pre-Columbian times. All the islands from Cuba to Trinidad once had a highly developed population, which remained until later times only in the Greater Antilles. It is probable that the aborigines of the Lesser Antilles came from South America, but those of the Greater Antilles from Central America.

At a meeting of the society, held November 17, 1914, in the public library, Rev. Dr. John Lee Maddox, chaplain in the United States Army, read a paper on "The Spirit Theory in Early Medicine." The primitive theory is that disease and death are abnormal, the work of malevolent spirits or of witchcraft. Many modern remedies and practises are the direct descendents of old-time methods and drugs intended to cure the patient by driving out an evil spirit through fear or disgust. Bitter medicines originated in revolting doses intended to disgust the demon. Massage originated in the beatings and poundings through which the evil spirit was to be frightened out of the patient. Bleeding, cupping and trephining were originally intended to facilitate its exit. Through long centuries, even with an incorrect theory, it was learned that certain drugs and remedies had a beneficial effect upon certain diseases. Thus the correct practise developed long before the correct theory. As examples of standard remedies derived from Indian doctors, he instanced ipecac and quinine. In the discussion Dr. Fewkes drew illustrations from the Hopi Indians, Mr. Mooney from the Cherokee, and Dr. Moore from the St. Lawrence Island Eskimo. Dr. E. L. Morgan and others also spoke.

Daniel Folkmar,
Secretary

SCIENCE

FRIDAY, APRIL 16, 1915

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE UNIVERSITIES AND INVESTIGATION[1]

As a representative of the university and as one but recently come to live among you, it is perhaps fitting that I should use the opportunity which President Hall has so kindly given me to discuss certain phases of university work in which many of my own chief interests lie, but which are not often brought before the attention of our public. I refer to the relations of the universities of the country to original investigation, and particularly to scientific investigation, since it is with a part of this—and necessarily in these days of specialization a small part—that I am personally concerned. Many of us in America have lived through a period in which the purposes and scope of the universities were at first not very clearly conceived; but as time has passed the situation has changed, and on the whole an agreement now prevails, which is likely to be permanent, regarding certain features of university policy which once were subjects of dispute. One of these is that investigation is an essential part of the work of every university. We now recognize that the universities have a double function to perform: one, that of disseminating liberal and scientific knowledge; the other, that of adding to it. There is nothing new in the idea that the chief concern of universities is liberal knowledge; *i. e.*, knowledge of a kind not directed primarily toward special or utilitarian or personal ends, but scientific or humane knowledge, relating especially to those matters which have a broad human significance and general applica-

[1] Founder's Day Address at Clark University.

bility. But in America it is only within the past twenty-five or thirty years that the universities have generally come to recognize it as their function to extend, as well as to maintain and transmit, such knowledge in all departments of learning. In a sense this is the more fundamental task of the two, since the attainment of scientific knowledge must precede its use in instruction or practical application; and it is perhaps the chief distinction of Clark University that it was one of the first to recognize and act on this principle. The day devoted to the memory of its founder seems thus an especially appropriate time for such a discussion.

Now investigation, in the scholarly or scientific sphere, means something more than the mere attempt to find something new. It means primarily all activity directed simply and solely toward the advancement of liberal knowledge—knowledge, that is, not of special or local or purely practical matters, but knowledge in its broader, more theoretical or purely humane aspects,—those which are concerned not so much with meeting the immediate occasion as with furnishing a generally valid basis of principles and methods that can be applied at will to all of the affairs of life. Breadth of application should be the main characteristic of this type of knowledge; it should meet not only the purposes of practical life, but also those of science and art, besides serving for the realization of the higher ideals of culture and conduct. The investigator knows that we can not assume all desirable knowledge of this kind to be already in existence and to be had for the asking; what we already possess has been gained chiefly by the prolonged and devoted efforts of previous investigators, working sometimes alone, sometimes in conjunction with others, and usually in universities or other institutions of learning; and we have to see to it that the task is carried on. That the task itself is a worthy one admits of no dispute; incalculable good has come to humanity through its means, and no doubt will continue to come if our efforts do not relax.

Why do so many seek knowledge without being seriously concerned about its application? This question is often asked, and its answer has puzzled many sincere persons. In various fields of science and culture we find men who seek knowledge with no other aim than to possess it. Is this aim worthy? Many, especially in these times, express doubts. Some even denounce such search as selfish. One hears such expressions as the selfishness of cultured persons. Yet those who do possess knowledge —worth calling by the name—are rarely troubled by such doubts. When Solomon rated wisdom as better than rubies, he no doubt expected that philosophers in general would agree with him, but not all other persons. Is it that a certain native endowment of intellect or temperament is required to take satisfaction in knowledge as knowledge, just as others delight in art as art? This is true in a measure, certainly; and the tendency has to be recognized and I believe encouraged. It is doubtful if an investigator or scholar in any field can be truly effective without this disinterested curiosity or simple desire to know; so that we must regard love of knowledge, even if it does not eventuate in action of any kind, as in itself desirable. Perhaps it is as well for it not to exist alone, but that is another question. There are, however, other and profounder—I might say biological—justifications for this tendency. Knowledge, in the biological interpretation, is the chief means of adjustment to the conditions of life. This is clear enough in practical life; if we *understand* a situation—have it clearly and accurately conceived in advance —we are better able to deal with it. The

same is true of even abstract or remote knowledge of the purely scholarly kind; it is *potential* means of adjustment; the cultured man knows how to adapt himself to most circumstances better than the uncultured man. Not only mankind, but all living organisms—both animals and plants—are so organized that their well-being depends on accurate adjustment to the conditions under which they live. The give and take of material and energy must balance; the term "adaptation" means simply the sum-total of the conditions that secure this balance. Now, for us men, the chief means of such adjustment is knowledge. Theoretical or abstract knowledge, the kind that investigators in pure science strive for, is merely that which is the most universally valid and applicable; it is therefore at bottom the most practical; so that if the chief aim of scientific investigation is the attainment of such knowledge, and even if the wish to attain it is often purely instinctive and unreasoned—as in fact it is in many of the best investigators—we can understand from the biological point of view why this should be so. Thus there is the best of sanctions for the knowledge-seeking tendency. Breadth of knowledge represents a surplus or reserve of potential activity,—whether it is actually called upon for use or not; and as such it is the most valuable possession that we can have, for it is the means by which purposes of any kind are rendered capable of realization.

Now let me define a little more fully what scientific men mean by investigation. Under this term come all efforts directed toward the one aim—the ascertainment of the clear, impersonal and objective truth concerning the matter in hand. Mankind has found no method that leads so certainly to the attainment of this end as the method of dispassionate, systematic and critical inquiry, using all available means impartially and thoroughly, and verifying all results once they are attained. In this sense scientific investigation is in no way different in its method from investigation in other fields, such as history, language or philosophy, or from the means which a good military commander or man of affairs adopts in familiarizing himself with a situation before he acts. In every case the aim is to ascertain impartially the actuality of the case, that which is *so*, quite independently of what our wishes or fears or other prepossessions may be. The means which we adopt may vary in different fields of investigation according to the nature of the matter under investigation; but the attitude of the true investigator is the same everywhere—an attitude of candid, critical, persistent and, above all, disinterested inquiry. It is important to realize the necessity for these qualities in the investigator, if true results are to be attained. Without them the purpose of investigation can not be realized; progress is slow, and results do not bear examination. Let me quote Faraday's conception of the natural philosopher—by which he means the investigator in natural science: "The philosopher," says Faraday, "should be a man willing to listen to every suggestion, but determined to judge for himself. He should not be biased by appearances; have no favorite hypotheses; be of no school and in doctrine have no master. He should not be a respecter of persons, but of things. If to these qualities be added industry, he may indeed hope to walk within the veil of the temple of nature." Here we have a statement, clear, simple and devoid of literary artifice, by one of the most fruitful scientific investigators of all times; and when we wonder at what has been accomplished by the science which has developed from beginnings largely made by him, we should remember that it is only by such men, working in such a spirit, that

the more fundamental truths can be brought to light. When, therefore, we say that we wish to encourage investigation, we really mean that we wish to encourage those who have the right spirit of investigation. Progress is due mainly to such men; and it is important in the interests of this progress that the universities, which devote so large a part of their resources to the work of investigation, should clearly recognize that the personal factor is still—as it was in Faraday's day—the all-essential. Knowledge, insight, and power of accomplishment are not in laboratories, libraries and organized institutions merely, but chiefly in those who put such means to their right uses.

It is needless, before an audience of this kind, to justify scientific investigation or to attempt to set forth something of what it has accomplished. I may, however, point out—since this has a bearing on much of what I wish to say later—one consideration which the world at large is prone to forget unless frequently reminded, namely, that it is the *fundamental* investigations which are chiefly important for science, and lay the foundations for those later applications affecting mankind generally. Thus in this sense we owe wireless telegraphy to Maxwell and Hertz rather than to Marconi, our freedom from many forms of disease to Pasteur, our mastery of the air to Langley and the others who studied the lifting power of moving planes; and many other similar examples could be given. In general we may say that if an adequate body of theoretical knowledge has once been gained, it is a relatively easy matter to make the desired practical applications. It is when there is no guiding theory and we have to work empirically that problems are difficult or impossible of solution. But if we know beforehand of any task that nothing but hard work and persistence is necessary for its accomplishment, we may say that there is no serious difficulty, for these qualities can be commanded at will in any civilized society. When, however, we lack the necessary knowledge of fundamentals, little or nothing can be done. I may here furnish an illustration from biological science. Until the relation of microorganisms to disease was discovered by Pasteur, physicians were almost helpless in many departments of medicine; but once this relation was established, means for indefinite advance were at once furnished; then, to use Ehrlich's phrase, "diligent empiricism" was all that was needed to master many problems of pathology; and, these once mastered, effective methods of diagnosis and treatment were forthcoming sooner or later. The relation of Faraday to electrical science is similar; and in the same sense engineering, scientific agriculture and mining, many valuable manufacturing industries, in short, all that is most characteristic in the material foundation of our civilization, could never have come into existence without the previous development of the pure sciences of physics, geology, chemistry and mathematics. Other and less tangible results are of equal importance, but it would lead too far to speak of these. I wish simply to make it clear that the fundamental knowledge must first be gained; and it is the task of the investigator to supply this knowledge. This he can do only by prolonged study, observation and experiment, directed toward the simple purpose of obtaining as full and clear insight as possible. In the pursuit of this aim problems inevitably arise that are both difficult and remote from popular interests; yet such problems must be solved, and it is largely for the purpose of providing opportunity and facilities for their solution that universities exist. This is why the greater part of research in pure science is necessarily conducted in the uni-

versities. On the other hand, experience has shown that those parts of scientific work which relate directly to useful applications can be carried on successfully under the pressure of general public demand; the material rewards of successful invention are a sufficient incentive to inventors. This, however, has never been true of investigation in fundamental fields of pure science, and it is difficult to see how it ever can be true. Such work itself is its own chief reward. Isolated men of genius may make great discoveries, as Boyle, Cavendish and Darwin have done in England; but in such cases fortunate circumstances and leisure are essential, and the number of such men is very small. For most investigators the opportunity of engaging in purely scientific or scholarly investigations is to be found only in the universities. The relation of universities to fundamental scientific progress is thus a peculiarly intimate one.

Advance in knowledge, as distinguished from the maintenance and application of existing knowledge, thus depends ultimately on the work of the investigator, and chiefly on the investigator in the university. If he is to accomplish his function he must direct his efforts to the practicable, under conditions that are favorable to his work—or at least not too unfavorable, for good will and talent can accomplish much in spite of adverse conditions. First, what is practicable? In his "Advancement of Learning" Bacon, the first advocate of systematic investigation, says:

> I take it those things are to be held possible which may be done by some person though not by every one, and which may be done by many, but not by any one, and which may be done in a succession of ages though not within the hourglass of one man's life; and which may be done by public designation though not by private endeavor.[2]

[2] I wish to express my indebtedness for this quotation to Dr. Mall's interesting article in the *Journal of the American Medical Association*, 1913, Vol. 60, p. 1599.

Bacon thus recognizes that many projects call for collective and coordinated endeavor, while others require individuals gifted with the necessary talents or opportunity. Collective action and individual action both play a part, and this is as true of the advance of science as of any other form of enterprise. Now it is a characteristic of our time and country that more stress seems to be laid on the importance of collective action or cooperation in scientific research, than on the importance of giving scope to the single investigator of original scientific genius. Whether this tendency is right or wrong I need not discuss just now. It is clear that cooperative research is essential for the solution of many scientific problems, especially those requiring the accumulation and coordination of large masses of data. Much of the work in statistics, heredity, astronomy, geology, sociology, and other sciences is of this nature; here are illustrated Bacon's classes of work "which may be done by many, but not by any one, or which may be done by public designation but not by private endeavor"; one has only to think of what is done by geological surveys, statistical associations, or scientific societies. Work which can not be done "within the hourglass of one man's life" may be well within the scope of an association; thus we have investigations relating to natural events which recur infrequently, like earthquakes or sunspot periods, or to processes which take place very slowly, like evolutionary changes in organisms, star movements, or other cosmic changes. Only the coordinated work of generations can throw light on such matters. Cooperative research thus plays an important part in the science of to-day, and there is a strong tendency on the part of many scientific men to insist on its all-sufficiency, and to regard the work of isolated or independent investigators as of minor consequence.

Bacon, however, mentions first of all the class of achievements that are possible to some one person, though not to every one. That in certain spheres of activity one person may be indefinitely superior to any other or even to any combination of others was familiar enough to Bacon, and social conditions were not then such as to obscure this truth or throw doubt upon it. Being a man of genius himself and an advocate of progress, he could not underrate the part which personal originality and power of invention play in progress; he knew that such qualities are of individual and not of social origin, although they naturally flourish best in a favorable social environment. It is perhaps time to protest against the tendency to undervalue detached investigators, which insists that every one shall work chiefly in cooperation with a group and for a collective aim. This tendency is undoubtedly strong at present, especially in America, because here the democratic spirit is more dominant than anywhere else and is subject to fewer corrective influences; and the resulting bias toward collectivism tends to lower the estimate placed on purely personal or individual qualities. Now reliance on "team-play" is well enough in its place; it plays an indispensable part in many undertakings. But such a spirit cannot be depended on to promote scientific progress by itself; in this sphere it is at best rather an accessory. The truth is that so far from progress depending on collective effort, the whole history of science shows that the guiding and fruitful ideas, those which form the seeds of later developments, nearly always originate in the minds of a few scattered thinkers or investigators, often working in isolation. Is there any reason to believe that this will not continue to be the case? Yet high scientific authority seems at times to encourage that belief. President Woodward, of the Carnegie Institution, in a recent address[3] warns his hearers against entertaining what he calls the subtle error that

> the more remarkable results of research are produced not by the better balanced minds, but by aberrant types of mind popularly designated by that word of ghostly if not ghastly implications, namely, genius.

Again he says:

> The more striking results of research, quite commonly in the past attributed to wizards and genii, and still so attributed by a majority perhaps of contemporary writers for the popular press, are now understood by the thoughtful to be the products rather of industry, sanity and prolonged labor than of any superhuman faculties.

Others extol cooperative research as the highest type of scientific work. But surely what is understood by scientific genius is not a wizard-like faculty of arriving at immediate and astonishing results, but rather that power of clear, imaginative and valid insight into phenomena which is the product of high native endowment combined with industry, sanity and prolonged labor. The peculiarities of pseudo-genius—which no doubt has besieged the Carnegie Institution for support from the beginning—should not be allowed to cast discredit on true genius, a totally different thing. When we understand clearly what scientific genius really is, we must recognize that it is no less indispensable to the production of the highest scientific work than is poetical genius to the production of the highest poetry. Every-day experience proves that industry, sanity and prolonged labor are not sufficient for the best work in any domain. It would be fortunate for humanity if it were so; for these qualities are not rare, and are in a measure attainable by all normal persons. Genius is not these—although when these are added genius may become more effective. Unfortunately—or perhaps fortunately—it evades rules; but it seems to

[3] SCIENCE, 1914, N. S., Vol. 40, p. 217.

include a strong instinctive element which appropriates or rejects the material which is presented to it—either by its own vivid imagination or by outside experience—according to the availability for the purposes that interest the genius. And this interest is likely to be absorbing to an extreme degree, and hence to arouse all the energies much more effectually than is usually possible to normal persons. But it is not necessary here to prejudge questions which are still a puzzle to psychologists. I wish merely to emphasize that whatever a final analysis may eventually show genius to be, there is no doubt of its existence, that it is rare, and that the chief achievements of mankind in science, as in art and literature, are due in the main to its activity. Only by recognizing these facts shall we be able to take properly into account all of the factors which contribute to scientific progress, and make due provision for all. If Darwin had been without means, there is no doubt that the most effectual way of promoting evolutionary science in his day would have been to provide him with an adequate personal endowment, or a university chair giving complete freedom for research. I emphasize this in order to bring to your attention the all-importance of the individual or personal factor in the work of scientific investigation. This consideration is a wholesome one for moderns to bear in mind; for the trust in cooperative methods, "team-play," and collective enterprise is so general, and has assumed such a dogmatic character, that it tends to deprive many persons—especially those whose talents are of a subtle rather than a robust order—of belief in their unaided personal powers, and hence to weaken their sense of personal responsibility. One result of this often is that they lose the normal and healthy compunction against laying up their talents in napkins.

Let us now return to our original subject. One of our aims in the universities is to further investigation. How are we to do this most effectually? The answer, in form at least, seems simple. First we must provide facilities, and second, we must have the right men. The first requirement is relatively easy; it is a question of material resources; the second is more difficult, as well as more important, for if it is impossible to make bricks without straw, it is still more certain that the best of straw will serve little for brick-making unless put into the right hands. But let us define a little more closely what we may regard as the conditions of successful research, with especial reference to the case of scientific departments in universities. In general three things are necessary; equipment, proper coordination of activities (or organization) and personnel. When these are combined in the right proportions we may hold that conditions are the most favorable; but this is not always possible, and usually some choice has to be made; which is the most important and fundamental? This question is not easy to answer; so much depends on what is under investigation; a completely and expensively equipped laboratory can undertake researches which are beyond the reach of one of more modest resources; and yet the difference in the importance of the results gained by the two may not be commensurate. Here we see the significance of the personal factor. Darwin will make important discoveries in his kitchen or back yard, while a costly laboratory, although making a great show of activity, may be comparatively fruitless in important results. This fact, however, does not make it any the less desirable that the apparatus for research should be at hand; but it indicates that if results are to come, such means should be used properly, and this can be done only by the right men. Appeals for

equipment have on the whole been well met in this country; and our relative lack of scientific productivity has little if any relation to lack of equipment. Nor is it for lack of numbers and organization that the universities fall short in scientific productivity. Everything that organization and system can do is done in our larger universities. Officers from the president down are numerous and minutely graded, hierarchy within hierarchy; there are departments and subdepartments; every subject is represented by one or more specialists; the courses given in a large department are numerous and detailed and cover all phases of the subject. The work of students is carefully supervised; so many credits go to the making of a master's, so many to a doctor's degree. No one is idle for a minute. The mere mechanism requires exacting care; the head of a department must often be primarily an executive; much of the time is given to duties of management; the telephone, the typewriter and the card-index are as much a part of his equipment as of the business magnate's. It would seem as if all of this machinery ought to be effective. Yet misgivings force their way in. There is reason to think that this faith in the efficacy of organization in university work is not derived from experience, but rather from a preconceived belief that methods which are so effective in practical life ought to be equally so in the intellectual life. But is this really so? Many of us have grave doubts. In our own private studies devotion to card-catalogues and notebooks can go too far, as many a man has found from bitter and paralyzing experience. Is it really true that the letter killeth, but the spirit giveth life? There must be conditions more important than equipment and organization—conditions which are somehow lacking. What are they and how can they be furnished?

It is for the universities to make the right answer to this question, and also to rectify the conditions. The majority of productive scholars and investigators are connected with universities. If the scientific productivity of the nation is less than it ought to be, as we see when we compare ourselves with Germany, France or England, we can only ascribe the deficiency to the presence of unsatisfactory conditions in the universities. What are these? and how are they to be removed?

Such a question carries very far and admits of no off-hand answer. The universities represent the intellectual tendencies of the country. They are, or ought to be, one of the chief sources of what is highest in its civilization. Why do fundamentally important contributions to science or scholarship come so infrequently? and is there any way of making them come more frequently? What man has done man can do: there must be some restricting and removable conditions which either prevent original investigators from doing their full quota of good work, or it may be prevent the creative type of scholar from finding his way into the universities in the numbers that we have a right to expect. What the chief of these conditions are, and how all those interested in the welfare of our institutions of learning can aid in their removal and replacement by better, is what I shall now try briefly to indicate. I ought perhaps to say that I offer my suggestions in a far from dogmatic spirit, being aware that the problem is highly complex, and that no one man can be fully familiar with all of its aspects.

When we look at our universities we are impressed with certain obvious peculiarities—their size, their wealth, the variety and complexity of their activities and of their organization. We may agree that size and wealth with the resources that they bring

are all very well—in themselves desirable—but complexity of organization, and the practises and tendencies that go with it? are these conducive to the intellectual life? This, in my opinion, is the critical question. So far from our taking this for granted, there is good reason to believe that beyond a certain limit dependence on system and organization in institutions of learning is directly injurious to good work, and this for the simple reason that it makes for the stereotyping of activities, and hence interferes with freedom and its expression, which is originality. Such restriction in fact is the general purpose of organization; it aims at diminishing variation from an accepted norm. Now the more stereotyped certain things are the better; thus a railway service or a department store can not be too regular and dependable; but if our aim is not simply to repeat things already done, but to discover new truth, the conditions that surround us, as well as our own temper of mind, should so far as possible encourage independent activity, and not simply that carried out in accordance with a program. In brief, purely routine activities should be subordinated in an institution of higher learning; all needless machinery should be disposed of, and the rest should be relegated to its proper place. This is a practical suggestion, and it is one of the first that I should make.

I do not, of course, wish to propose anything impracticable, and I am aware that a certain degree of established order, inseparable from organization of some kind, is necessary to stability and efficiency even in an institution devoted purely to research. But what I maintain is that the aim should be a minimum rather than a maximum of organization, and that the ideal toward which universities should work, if they regard original scholarship as something which it is their serious duty to further, is the attainment of the greatest possible freedom in the work of the individual departments and of the scholars making up those departments. A system of separate colleges, as in the English universities, or of autonomous departments, as in the German and some American universities, seems to give the best results. Such an ideal should not be left to chance, but it should be held consciously; and every one in the university should regard such freedom as the chief condition of his effective activity and should oppose vigorously every attempt to infringe upon it. Liberation must come from within rather than from without, and as the result of a more widespread insistence on the importance of personal freedom and initiative. This spirit would be incompatible with the over-developed autocracy that has aroused so much complaint. Freedom from merely petty and distracting activities would then soon come, and more men would give the best part of their attention to things that are seriously worth while.

The university should be the stronghold of individuality. Every one's serious interests should be respected and furthered so far as possible, both out of regard for personal freedom, and also because we do not know what their potential value may be. Remember that our aim as original scholars is not simply to impart what is already known and valued, but to produce something new, whose value to the world may not be in the least evident at first. But who can tell what its value may be later? Besides, it may be of value to the few if not to the many. We must recognize that the needs of men are as various as their characters and capabilities. A tolerance, open-mindedness, and detachment are thus of the essence of true academic life. An unwillingness to interfere needlessly, coupled with a determination to adhere by

high standards, may indeed be said to be the chief criterion of a high civilization.

There is reason to believe that the democratic movement of our time has in many ways been unfavorable to the development of strong individuality in the fields of science, literature and the arts. The collective spirit is now dominant, especially in America, and even in academic life many are unduly influenced by the desire of producing work which will make a direct appeal to the community at large, rather than work which is new and meritorious in itself, irrespective of whether it is popular or not. This spirit is inconsistent with disinterestedness, and hence tends to repress originality. It is hard to escape its influence; it constitutes an atmosphere—that element which is at once the most intangible and the most essential to life. We can however resist it if we only wish; and a spirit of independence or self-respect, that refuses to have its standards determined by anything short of firmly grounded personal conviction is the best safeguard. There is a sense in which too easy submission to the prejudices of a majority is like too easy submission to the dictates of a king or emperor. In either case the result is weakening to individuality, and hence to all work, like the work of scholarship, which demands independence and individuality.

We must remember that we are living in a time which tends to regard the collective welfare as the chief if not the only legitimate object of action. In one sense this is a great source of encouragement; it augurs well for the future of humanity at large; but it has its drawbacks. Little attention is paid, except by a few detached persons here and there, to the danger of having the whole national spirit dominated by the belief that nothing but work in the interest of large numbers is of any importance. Related to this is another very characteristic tendency. Where so many questions in politics and practical life are decided by counting of heads, a strong bias in favor of mere numbers is inevitable. Now there may be no disadvantage in this unless it becomes instinctive, *i. e.*, acted upon automatically and uncritically; but it is just this instinctive prejudice that prevails so strongly nowadays. All forms of activity share its influence; and it shows itself in educational institutions and universities in such phenomena as an over-insistence on the importance of large enrolments, the conferring of too numerous degrees, and a distinct and widespread tendency to leniency in the standards of quality. Public opinion in a democracy favors these manifestations, and an institution dependent on public opinion for its support can not afford to be too unsympathetic toward them. But a danger lies here, which is perhaps the more insidious since it can be recognized and guarded against by comparatively few. If we work only in the interest of and at the bid of majorities, we are in grave danger of disregarding the claims of the minorities. And this means undervaluing those types of person who are necessarily always in the minority, *i. e.*, exceptional persons of all kinds. The curious result follows that in a democracy, the political system which is theoretically the most favorable to liberty, the individual, regarded as an individual—and not as representative of a group (whose numbers may entitle it to respect)—often meets with little consideration. In other words, too much respect for collectivism tends to impair the respect which is due the individual, and personal liberty suffers. There arises a tendency to treat all persons in the mass, undiscriminatingly; and necessary distinctions fail to be made. Complaints of the low estimate which the democracies of England, France and America place on even the best and most gifted in-

dividuals have been appearing somewhat frequently of late; Faguet even says that the equalitarianism of the time leads to a distrust of all but mediocre persons in every capacity, and indeed favors a cult of incompetence; and he ascribes much of the inefficiency and shiftlessness of democracies to this tendency. This may be partly overstatement for purposes of emphasis; but it is at least clear that if the universities are to do their best work they should be consciously on their guard against such tendencies. We must remember that in a sense the statement that all men are equal is a dogma adopted primarily for political purposes; as such it embodies an important principle, and it serves to simplify the technique of representative government; but it was never meant to controvert plain facts. In any case we must avoid being influenced by it to the extent of disregarding talent and failing to do our best to single it out and develop it. Real progress can come only in this way. This policy, however, seems to be unpopular at present, and as a rule is little acted on in our universities. Thus the attempt to make a definite distinction between "honor" men and "pass" men—a distinction corresponding on the whole to that between those who seriously wish to study a subject and those who have no particular interest in it—is opposed as undemocratic. One often gains the impression that talented students do not try their best, because they have a feeling that it is not quite considerate or democratic for one man to prove himself the intellectual superior of another. Why this should be so is one of the mysteries; there is no such feeling about games like tennis. It may be that it represents a defensive reaction in the biological sense; it is said that white sparrows are badly treated by normal birds; and no doubt many persons feel safer when they identify themselves with a group than when they stand alone. The spirit of hostility to distinction is, however, peculiarly out of place in universities. It is difficult to judge our own community and our own time; we are subject to the fallacy of nearness; but there is little doubt that a general desire to regulate the activities of the individual in the supposed interest of the group is at present one of the most characteristic manifestations of the time-spirit, and that a submission to this desire by persons who think it democratic so to submit is responsible for a certain lack of distinction and originality in the intellectual activities of the day. The way in which organizations and societies flourish is a symptom of this; the remark has recently been made that whenever two or three are gathered together nowadays some one else is sure to be on his way to organize them; and this propensity encourages the individual in a kind of fatalistic belief that he can accomplish nothing working alone. Under these conditions, if he fails, he is often inclined to cast the blame on the organization to which he belongs or on the community rather than on himself.

It is essential that we should continue to regard the university as a place where individual talents of the most special kind will receive encouragement and development, as a place of preparation for leadership, and equally for the discouragement of any inclination to lean unduly on the rest of the community. The university man should be able to think for himself and by himself. No one can say what the potentiality of any one may be; if, therefore, a student is conscious that he has any special bent or enthusiasm for any subject, he should not hesitate to give his chief energies to its cultivation. It may be that he will meet with little sympathy from the outside world, or even from his intimates; but this should be no cause for discouragement. The univer-

sity exists largely to give opportunity to men of this kind. He must get over the feeling that it is necessary, or at least fitting, to apologize for the unpractical nature of his activities. The university is aware that many things can be done only by taking thought, just as others require immediate action without any particular thought. There is inevitably isolation and detachment in much of the work of universities; this is especially true of the work of investigation. Remember Wordsworth's lines on Newton's statue at Cambridge University:

> The marble index of a mind forever
> Wandering through strange fields of thought alone.

The withdrawal of such a man from the world is deliberate; only so can his purposes be achieved.

This withdrawal imprints a characteristic quality on academic life, with which it is often reproached. The very word academic is often popularly or journalistically used to signify remoteness from actuality. It might with equal justice be used as signifying *nearness* to actuality; but the fact is simply that the university recognizes as important or even pressing actualities many matters which to the world at large are virtually non-existent. The apparent ineffectuality of much academic work is a serious grievance to many people; and certain movements directed toward the radical modification of time-honored academic usages and privileges have arisen as the expression of this feeling; some persons, no doubt conscientious, have favored a system of supervision and time-keeping, with the object—laudable, no doubt, if only it were practicable—of making sure that the holders of university chairs do not waste their time. But it is just here that the uninitiated judgment is likely to lose its bearings; and we may well continue to repeat with the Sybil: "Procul este, profani!" Who is to be the judge in these matters? Who will guard the guardians? What constitutes effectuality in the intellectual sphere? We must refuse to be misguided by false criteria in these matters. What is most effectual in the activities of the scholar can not always be discerned even by his immediate associates. Nothing but the perfect witness of all-judging Jove would suffice for this. The true criteria are not evident to those ignorant of his work; and in forming an estimate of its value, confidence and respect for individuality have to be combined with the judgment passed by his peers in the learned world. If for lack of sympathy or special knowledge we fail to see the value of certain fields of scholarly work, there is nothing for it but to accept the assurances of those who know. Their judgment is likely to be critical enough, and not to err on the side of leniency. All plans of imposing upon the scholar rigid requirements from without—apart from the necessary responsibilities of teaching and contributing to his subject—are impracticable. I have mentioned certain recent attempts directed toward a closer external oversight of academic work; the authors of these attempts have urged that it would be well, in the interests of "efficiency," to estimate more closely the time which the occupants of university chairs devote daily to research, to teaching and to other activities. This is officialism run mad, you may say; but there the fact stands. Some one, well known as a defender of academic freedom, has remarked that the only really effective scientific mind works twenty-four hours a day. In saying this he may have had in mind Landor's passage:

> The capacious mind neither rises nor sinks, neither labors nor rests, in vain; even in those intervals when it loses the consciousness of its powers it acquires or recovers strength, as the body does by sleep.

If this is true, it is clear that all such attempts to enforce scientific productivity—usually under the delusion that it represents measurable and controllable "output" like the products of a factory—are futile, and overlook the essential requirements of all original work, which are simply opportunity, freedom from needless distraction, and the necessary leisure.

Regarding this last requirement a word or two is peculiarly apposite nowadays. Jesus, the son of Sirach, says: "The wisdom of a learned man cometh by opportunity of leisure"; and he goes on to explain that merely multifarious activities of the more obvious kind are injurious to such a man, since they hinder and distract him from more worthy tasks, and prevent his accomplishing what is truly worth while. For this, tranquillity is needed, and the depth that comes from prolonged and undisturbed concentration. This is an essential condition for the work of investigation; activity is useless unless properly directed; but direction requires thought; and thought requires time for thinking—which is leisure. Wordsworth says very profoundly in "Laodameia":

> . . . The Gods approve
> The depth and not the tumult of the soul.

I do not know of any more suitable motto for a university than just this. For, after all, it is depth we want; and no degree of external activity, however effective or apparently beneficial, can make up for its lack. But how can it be gained without leisure—freedom for thought and study and research, and belief in their efficacy and saving grace? Such freedom is the source of all spontaneity and originality. You all remember how, when an admirer expressed his delight over the perfection and inevitability of a line of Tennyson, and said he knew *that* was a pure stroke of inspiration, the poet replied: "Well, I smoked three pipes over that line." Now it may be that not all affairs can be conducted in that way; we in the universities should recognize this and not be disturbed by it, while maintaining, nevertheless, that our ways are different. We form a sanctuary for all those who, whether by smoking pipes or otherwise, can by the power of thought, and activity directed by thought, attain the essential truth in any matter. I do not speak here of the beautiful; that is the realm of art. But in scholarship what is essential is *ideas;* it is these which give value and interest to the often dry details of investigation, and which guide and inspire the work of gathering fresh detail. We find that if we have the ideas we can usually test their validity without great difficulty; but they are the indispensable, and we can not get them without thinking and studying deeply. For that we require leisure. I dwell on these considerations because there is little doubt that our day and generation does not sufficiently recognize the need of leisure in academic life, and often misunderstands its purpose. Yet it is essential that there should be an atmosphere of leisure—of freedom from external compulsion—in the universities, if they are to be fully and adequately productive in original scholarship. We must understand clearly the purpose of such leisure, which is simply to afford opportunity—not for idleness, as I need hardly say, but for fruitful independent effort. In this sense leisure should be the chief prerogative of the educated man everywhere. It really implies nothing but freedom, and for its proper use both discipline and high purpose are needed. The knowledge and the will to use freedom rightly—surely these are what all who are truly educated ought to have; and we must be willing first of all to assume that those who are entrusted with the tasks of education and the advancement of learning are

especially fit to be entrusted with their own freedom. It is likely that an enlightened society can be relied on to recognize this; but it is particularly the duty of the universities, if they believe in their own best traditions, to speak with no uncertain voice. We look chiefly to them for progress in those fundamental fields of knowledge which ultimately concern more intimately than any others the future of civilization; and if they are to continue their leadership they must show that they value above all immediate advantages the tradition of academic freedom.

Ralph S. Lillie

Clark University,
February 1, 1914

THE NATIONAL ACADEMY OF SCIENCES

The Academy will hold its annual meeting at Washington on April 19, 20, 21, 1915. The program is as follows:

MONDAY, APRIL 19

10 A.M.—Business meeting of the Academy in the Oak Room of the Hotel Raleigh.

1 P.M.—Luncheon in the private dining-room of the Hotel Raleigh.

2.30 P.M.—Auditorium, National Museum. Public scientific session:

Thomas H. Morgan: "Localization of the Hereditary Material in Germ Cells." (30 minutes.)

Problems of Nutrition and Growth:

Jacques Loeb: "Stimulation of Growth." (30 minutes.)

Lafayette B. Mendel: "Specific Chemical Aspects of Growth." (30 minutes.)

Eugene F. Du Bois, medical director, Russell Sage Institute of Pathology (by invitation of the program committee): "Basal Metabolism during the Period of Growth." (30 minutes.)

I. S. Kleiner and S. J. Meltzer: "Retention in the Circulation of Injected Dextrose in Depancreatized Animals and the Effect of an Intravenous Injection of an Emulsion of Pancreas upon this Retention." (10 minutes.)

5 P.M.—Meeting of the editors of the *Proceedings*, Cosmos Club.

8 P.M.—Auditorium, National Museum.

First William Ellery Hale Lecture, by Thomas Chrowder Chamberlin, of the University of Chicago. Subject: "The Evolution of the Earth." (Illustrated.)

The lecture will be followed by a conversazione in the Art Gallery of the National Museum.

TUESDAY, APRIL 20

10 A.M.—Auditorium, National Museum. Public scientific session:

Joel Stebbins, Draper Medallist: "The Electrical Photometry of Stars." (30 minutes, illustrated.)

George E. Hale: "A Vortex Hypothesis of Sun Spots." (20 minutes, illustrated.)

Edwin B. Frost: "The Spectroscopic Binary, Mu Orionis." (10 minutes, illustrated.)

Robert W. Wood: "One-dimensional Gases and the Experimental Determination of the Law of Reflection for Gas Molecules." (10 minutes, illustrated.)

Robert W. Wood: "The Relation between Resonance and Absorption Spectra." (15 minutes, illustrated.)

Edward L. Nichols and H. L. Howes: "On the Polarized Fluorescence of Ammonio-Uranyl Chloride." (15 minutes, illustrated.)

Robert A. Millikan (by invitation of the Program Committee): "Atomism in Modern Physics." (30 minutes, illustrated.)

1 P.M.—Luncheon in the Oak Room of the Hotel Raleigh.

2.30 P.M.—Auditorium, National Museum. Public scientific session:

William Morris Davis: "Problems Associated with the Origin of Coral Reefs, suggested by a Shaler Memorial Study of the Reefs of Fiji, New Caledonia, Loyalty Islands, New Hebrides, Queensland and the Society Islands, in 1914." (60 minutes, illustrated.)

F. W. Clarke: "Inorganic Constituents of Marine Invertebrates." (15 minutes.)

Roy L. Moodie (introduced by Henry Fairfield Osborn): "Amphibia and Reptilia of the American Carboniferous." (15 minutes, illustrated.)

Henry Fairfield Osborn and J. Howard McGregor: "Human Races of the Old Stone Age of Europe, the Geologic Time of their Appearance, their Racial and Anatomical Characters." (15 minutes, illustrated.)

Charles A. Davis, geologist, Bureau of Mines (by invitation of the Program Committee): "On the Fossil Algæ of the Petroleum-yielding Shales of the Green River Formation." (15 minutes, illustrated.)

Nathaniel L. Britton: "The Forests of Porto Rico." (10 minutes.)

J. Walter Fewkes: "Pictures on Prehistoric Pottery from the Mimbres Valley in New Mexico, and their Relation to Those of Casas Grandes." (20 minutes, illustrated.)

Charles B. Davenport: "Inheritance of Temperament." (15 minutes.)

Charles B. Davenport: "Inheritance of Huntington's Chorea." (12 minutes.)

8 P.M.—Annual dinner of the members of the Academy and their guests and presentation of the Draper medal, held in the Oak Room of the Hotel Raleigh.

WEDNESDAY, APRIL 21

10 A.M.—Oak Room, Hotel Raleigh.

Business meeting of the Academy for the election of members and two members of the council.

1.30 P.M.—Luncheon in the private dining-room of the Hotel Raleigh.

2.45 P.M.—Auditorium, National Museum.

Public scientific session. George H. Parker, official representative of the academy upon the Special Commission appointed by the President of the United States to study and report upon the Alaskan fur seals during the summer of 1914. Subject: "The Fur-Seal Herd of the Pribilof Islands." (Illustrated.)

4 P.M.—Auditorium, National Museum.

Second William Ellery Hale Lecture, by Thomas Chrowder Chamberlin, of the University of Chicago. (Open to the public.) Subject: "The Evolution of the Earth." (Illustrated.)

JACQUES LOEB: *Stimulation of Growth.*

The speaker intends to discuss the stimuli which induce development and growth in three cases.

1. *Artificial parthenogenesis*, or the nature of conditions which cause the egg to develop. It has been shown that all substances which cause a cytolysis of the surface layer of the egg start the development; and that the spermatozoon must contain a substance of that character; but that in addition a second treatment is required to insure a more normal development. The alteration of the surface layer increases the rate of oxidations in the egg by 400 to 600 per cent. and the same effect is produced by the entrance of the spermatozoon into the egg.

It seems that under certain conditions this alteration of the surface is reversible and it is inferred but not yet proven that in this case the acceleration of the rate of oxidations is reversed. This reversibility is a fundamental fact, since the alteration of conditions of active growth and rest are a prerequisite for the continuity of life.

2. *Metamorphosis.* Phenomena of growth occur in the larval metamorphosis when certain organs disappear and new ones begin to grow. A number of facts have indicated that substances circulating in the blood are responsible for these phenomena of growth and this conclusion was put on a permanent basis by the discovery of Gudernatsch that it is possible to induce in tadpoles at any time the outgrowth of legs and complete metamorphosis by feeding them with thyroid.

3. *Regeneration.* By regeneration we mean the phenomena of growth started by the removal of some part. It can be shown that in these cases also the growth is induced by the collection of (probably specific) substances at places where they could not gather under normal conditions.

LAFAYETTE B. MENDEL: *Specific Chemical Aspects of Growth.*

A review of the methods employed in the investigation of chemical problems of growth. Analysis of the tissues of growing individuals has failed to contribute much of specific importance, owing to the tendency of the body to maintain a fixity of composition under varying conditions of diet. The study of nutrition in growth is more profitable. This has involved a determination of the constructive units essential for the building up of an adult organism. Recent contributions respecting the rôle of the individual nutrients, and particularly the proteins, are considered. The part played by the amino acids derived from proteins in digestion has been investigated. Some of these can be synthesized in the organisms; others apparently can not, and must be furnished in some form in the dietary. The newer researches suggest that in addition to the familiar foodstuffs certain as yet undetermined food accessories (also called "vitamines") are needed. The evidence for this view and the facts regarding the existence of special chemical determinants of growth are discussed.

EUGENE F. DU BOIS: *The Basal Metabolism during the Period of Growth.*

In order to compare the basal metabolism of children with that of adults it is best to use as a basis the calories per square meter of body surface per hour. The average figure for men is 34.7 calories with a plus or minus variation of 10 per cent. For a short time after birth the average for infants is 20 per cent. below this figure. The metabolism then rises rapidly and reaches a point 50 per cent. above the adult level at the age of 2 years, remaining at this height until the age of 6

years, then falling steadily until the age of 19. From this point there is very slight decrease before old age is reached. During convalescence from typhoid fever the curve of metabolism is similar to that of childhood. The evidence points towards an increased metabolism of growing tissue. The fact that the liver and thyroid gland are relatively large in children may account for part of the increase.

I. S. Kleiner and S. J. Meltzer: *Retention in the Circulation of Injected Dextrose in Depancreatized Animals and the Effect of an Intravenous Injection of an Emulsion of Pancreas upon this Retention.* Preliminary communication. Presented by S. J. Meltzer.

When dextrose is injected intravenously into normal animals, even in large quantities, it disappears rapidly from the circulation, and the sugar content of the blood is, in a short time, quite normal again. In previous investigations the authors found that in depancreatized dogs there is a tendency for the circulation to retain for a longer period a part of the injected dextrose. In recent experiments it was further found that, when with the infusion of dextrose in depancreatized dogs an emulsion of pancreas is simultaneously injected, the circulation seems to lose its power to retain the injected dextrose. These experiments seem, therefore, to show that the power of the circulation to rid itself of a surplus of sugar is due to the influence of an internal secretion of the pancreas.

R. A. Millikan: *Atomism in Modern Physics.*

Atomism in modern physics begins with Dalton's discovery in 1803 of exact multiple relationships between the combining powers of the elements. Out of this discovery grew the whole of modern chemistry. The second tremendously important step was taken in 1815 when Prout pointed out that the atomic weights of the lighter elements appeared to be exact multiples of that of hydrogen, thus suggesting that hydrogen was itself the primordial element. The periodic table of Mendeleef added support to such a point of view, and Mosley's recent brilliant discovery through the study of X-ray spectra of a new series of multiple relationships, represented by a consecutive series of atomic numbers from 13 up to 79 with every number except three corresponding to a known element, is another most significant bit of evidence. When we add to this three other facts, namely, (1) that each member of a radioactive family, like the uranium family, has been definitely shown to be produced from its immediate ancestor by the loss by that ancestor of one atom of helium (which is almost equal in weight to four atoms of hydrogen), (2) that in an atomic weight table the differences between the weights of adjacent elements are in almost every case exact multiples of the weight of the hydrogen atom, the characteristic helium difference 4 appearing with extraordinary frequency, and (3) the fact that the introduction of the concept of electro-magnetic mass, and the consequent discovery of the inconstancy of mass, open several ways of explaining the slight departures in the exactness of the multiple relations between atomic weights pointed out by Prout, it will be evident that modern science may well feel fairly confident that it has indeed found in hydrogen the primordial atom which enters into the structure of all the elements. All this is merely a very modern verification of very ancient points of view.

But modern physics has recently taken a more significant and more fundamental step than this, for it has looked inside the atom with the aid of X-rays and other ionizing agents, and has there come upon electrically charged bodies, whose inertia or mass is wholly accounted for, at least in the case of the negative elements, by their charges. This discovery marks the fusing into one another of two streams of physical investigation, namely, the molecular stream and the electrical stream. A necessary condition for the justification of this last step was the bringing forward of indubitable proof that the thing which has heretofore been called electricity is after all, contrary to Maxwell's view, a definite material substance in the sense that it exists in every charge in the form of discrete elements; in other words, that it too like matter is atomic or granular in structure. Such proof was found in the discovery in the oil drop experiments of even more exact multiple relationships between all the possible charges which can be put on a given body than Dalton had ever discovered between combining powers or Prout between atomic weights or Moseley between X-ray frequencies. The greatest common divisor of this series of charges is then the ultimate unit or atom of electricity which has been named the "electron." New evidence that it is indeed a universal and invariable natural constant will be brought forward and a new determination of its value will be presented.

It is obvious that as soon as we could assert that these electrons are found in the hydrogen atom it was necessary to suppose that a single hydrogen atom contains at least two such electrons, one positive and one negative, and as a matter of

fact the evidence is now strong that it consists of exactly two. This twentieth century has then discovered for the first time a new subatomic world of electrons, the constituents of atoms.

All this is definite and probably permanent. But atomic conceptions in more or less vague form have also begun to invade the one remaining field of physical investigation, namely, the field of ethereal radiations. The most significant of recently discovered facts in the domain of radiant energy are these:

(1) Ethereal radiations when absorbed by matter, if they are of high enough frequency, will detach one and only one electron from a single atom. (2) The energy transferred to this electron from the ether wave is independent of the intensity of the incident radiation. (3) It is also independent of the kind of matter from which the electron is taken, but (4) it is exactly proportional to the frequency of the ether wave which detaches it.

These facts are stated in an equation set up tentatively by Einstein in 1905, and arrived at by him from the standpoint of a modified corpuscular theory of radiation. New proofs of the exactness of Einstein's equation will be presented and the evidence for and against Einstein's conception will be discussed. Whether the conception ultimately stands or falls, it appears probable, at any rate, that an equation has been obtained which is to be of no less importance in future physics than Maxwell's equation of the electro-magnetic field, and which seems destined to unlock for the physicists of the future the doors to the understanding of the relations existing between matter and radiant energy.

W. M. Davis: *Problems Associated with the Origin of Coral Reefs suggested by a Shaler Memorial Study of the Reefs of the Fiji, New Caledonia, Loyalty Islands, New Hebrides, Queensland and the Society Islands.* (Illustrated.)

The sea-level coral reefs of the Pacific are singularly non-committal as to their origin. The visible reefs accommodate themselves indifferently to any one of the eight or nine theories invented for their explanation. Hence a choice among the theories must be guided not so much by a study of the reefs themselves as by a study of associated phenomena, which thus gain an unexpected importance in coral reef investigation. It is because the associated phenomena have been insufficiently studied that so many contradictory theories have found favor. Of all associated phenomena, those provided by the central islands within barrier reefs are the most accessible and the least equivocal; next in importance are those offered by uplifted and dissected reefs. It will be shown by means of landscape views and theoretical diagrams that no theory accounts for all the facts—those of the associated phenomena as well as those of sea-level reefs—so well as Darwin's original theory of subsidence; and that the strongest confirmation of Darwin's theory is given by the embayments of the central islands within barrier reefs, as was long ago pointed out by Dana. Thus the results now reached regarding the reefs of the Pacific agree with the conclusions announced in recent years by several Australasian observers. It is believed that the several alternative theories advocated by various investigators during the last thirty-five years will be given up, and that Darwin's theory of subsidence will regain the general acceptance that it formerly enjoyed (1840-80).

George E. Hale: *Some Vortex Experiments on the Motion of Sun-spots.*

A closely wound helix of brass wire, with circular disks threaded on it, is hung vertically in water and spun at high velocity. The columnar vortex thus formed gradually changes into a semicircular vortex ring, by the rise of the lower end of the helix until it meets the surface. Thus the second sun-spot in a typical bipolar group might be formed by the turning up of the columnar vortex assumed to constitute a single spot. Preliminary rotation of the whole mass of liquid retards or prevents the turning up process if in the same direction as that of the helix, and hastens it if in the opposite direction. Hence, a persistent single spot may represent a rotating gaseous column whose diameter is large in comparison with its length.

Circular or semicircular vortices have a proper motion at right angles to their planes, in the direction of motion of the inner edge of the whirling ring. As high and low latitude bipolar spots rotate in opposite directions, they should, therefore, move toward the pole and the equator, respectively. Carrington's observations show this to be the case. The velocity to be expected is being determined by measuring the velocity of vortex rings in liquids and compressed gases. Observations of the stream-lines of ionized smoke particles, above single and double magnetic vortices representing sun-spots, are also in progress.

F. W. Clarke: *The Inorganic Constituents of Marine Invertebrates.*

Essentially a report of progress. The object of the investigation is to determine, more systematically than has been done hitherto, just what each

group of organisms contributes to the marine sediments, and therefore to the formation of marine limestones and especially to their magnesian and phosphatic varieties. The work is practically complete as regards the true corals, the mollusks, the brachiopods and the echinoderms. The inorganic constituents of the corals and mollusks are mainly calcium carbonate, with insignificant impurities. The echinoderms are all more or less magnesian, their skeletons containing from 6 to 14 per cent. of magnesium carbonate. The brachiopods fall into two groups, the shells of one group being mainly calcium carbonate with little organic matter; while those of the other group are essentially calcium phosphate with much organic matter. Work is yet to be done on the foraminifera, the coralline hydrozoans, the bryozoans, sponges and crustaceans. Some of the results so far obtained are novel, others merely confirm the older recorded observations.

Charles A. Davis: *On the Fossil Algæ of the Petroleum-yielding Shales of the Green River Formation.*

The Green River shales of Eocene age are known from northwestern Colorado, west into Utah and north into Wyoming. In places they are more than 3,000 feet thick. They are usually hard, tough, compact and fine-grained and brown in color, but weather to light gray or whitish. Certain beds are highly carbonaceous, burn freely and appear like lignite. Freshly broken surfaces give off a bituminous odor but never appear oily; when heated in closed retorts, petroleum passes off among the distillates.

By special treatment this shale has been sectioned to any desired thinness with a microtome. Microscopic examination of such sections from samples yielding abundant petroleum on distillation, shows the shale to be composed largely of organic matter, chiefly of vegetable origin, as well-preserved plant remains are common.

The most conspicuous plants observed are microscopic algae, which are very numerous in the slides so far studied.

The discovery of a very considerable algal flora in this great and but slightly altered series of petroleum-yielding shales is of especial interest because of the light it may throw on the origin of petroleum and related compounds.

(A few lantern slides from microphotographs of fossil algæ from the shales will be shown.)

J. Walter Fewkes: *Pictures on Prehistoric Pottery from the Mimbres Valley in New Mexico, and their Relation to those of Casas Grandes.*

The unexpected discovery near Deming, New Mexico, of an exceptionally large number of vessels, made of earthenware, decorated with paintings of mythic animals and men, has led to an enlarged knowledge of the prehistoric culture of our southwest. These pictures, unknown a year ago, have been found in great abundance, and are highly characteristic. Those representing men engaged in various occupations are particularly valuable in the light they throw on ancient manners and customs.

These pictures were painted by a people antedating the nomads found in the Mimbres Valley by the first white visitors, and who disappeared before the beginning of the historic epoch. The pictures have archaic characteristics that point to a remote antiquity as compared to that on modern pueblo pottery.

The cause of the disappearance of this culture from the Mimbres Valley can be traced to local influences rather than to widespread modifications of climate. One of the important local causes of the abandonment of the prehistoric settlements when they were found, was a change in the course of the river.

The geographical isolation of the Mimbres Valley has played an important rôle in developing the peculiar culture these pictures express, while its north and south extension has facilitated interchanges of cultures leading to far-reaching resemblances in these directions.

C. B. Davenport: *Inheritance of Huntington's Chorea.*

Huntington's chorea is a name applied to a group of symptoms first brought together as an entity by Dr. George S. Huntington. The traits involved are four: (1) persistent tremors over a less or greater part of the body; (2) their onset in middle or late life; (3) their progressive nature, and (4) a progressive mental deterioration. Analysis of many chorea-bearing fraternities shows that this supposed neuropathic entity is really only a syndrome inasmuch as, in the choreic families, mental deterioration may appear without tremors, the tremors may progress without mental symptoms, the mental symptoms may not progress and the onset of the disease may be in early life. Indeed, an analysis of families reveals the presence of biotypes characterized by specific forms of choreic involvement and progression. In the inheritance of the elements of the syndrome the choreic movements are clearly a dominant trait; some of the elements of the mental condition (which is usually allied to manic-depressive insanity) are also dominant. The law of anticipation in successive generations

in the age of onset is shown probably to have a merely statistical significance.

C. B. DAVENPORT: *Inheritance of Temperament.*

An analysis of matings between persons who have a prevailingly elated and those who have a prevailingly depressed temperament indicates that the temperament of the former is inherited as a simple dominant, that of the latter as a recessive, but not allelomorphic to elation. In F_2 and later generations the zygotic combinations are complex, including elated, depressed, alternating, normal and intermediate grades. Thus with a knowledge of ancestry sufficient to infer the gametic composition of the parents the distribution of temperaments for the offspring may, within limits, be predicted.

G. H. PARKER: *The Fur-seal Herd of the Pribilof Islands.*

The Alaskan fur-seals are pelagic animals that, during the summer, come ashore on the Pribilof Island for the purpose of breeding. The adult males, or bulls, arrive on the islands in May and June followed by the females, or cows. A bull may have associated with him from one to over a hundred cows, and this assembly constitutes a harem. Each cow, shortly after her arrival, gives birth to one young seal, or pup, and soon thereafter becomes again pregnant. The period of gestation is a little less than a year. The seals in the main leave the islands for the open sea early in the autumn. In 1914 there were born on the Pribilof Island over 93,000 seals and the total herd was estimated to be slightly under 300,000, a fair increase over the former year. As there are about equal numbers of males and females born and as the average harem is composed of one male and about sixty females, there are under normal conditions a considerable number of excess males, the so-called idle bulls. The number of idle bulls is a measure of the lack of adaptation in the proportion of sexes and indicative of a certain inefficiency on the part of nature.

ARTHUR L. DAY,
Home Secretary

SMITHSONIAN INSTITUTION,
WASHINGTON, D. C.

EBERHARD FRAAS

FROM Stuttgart comes the very sad news of the death upon March sixth of the very distinguished paleontologist, Dr. Eberhard Fraas, professor in the university and head of the Royal Museum of Natural History. On the very day following, namely, March 7, the widow of Professor Fraas learned of the death of their only son, Hans Oscar Fraas, in the Argonne near Vauqois, on March 1. The young man was twenty-two years of age.

Eberhard Fraas was one of the most talented pupils of Karl von Zittel, at Munich, and was one of the ablest and broadest of the vertebrate paleontologists of Europe. Besides his explorations, chiefly in the marine and terrestrial Trias and Upper Permian of Württemberg, he traveled widely through other parts of Europe, and made an extensive journey accompanied by the writer through the Jurassic-Cretaceous exposures of the Rocky Mountain region. It was, however, his journey to the dinosaur beds of German East Africa some years ago which very seriously impaired his health and necessitated one or two surgical operations from which he never fully recovered, so that although a man of superb physique his death came at the early age of fifty-two.

He leaves as his monument great collections of vertebrate fossils, especially in the museum at Stuttgart, including the phytosaurs and carnivorous dinosaurs of the Trias and many of the very early and most rare of the Testudinata besides a superb collection of ichthyosaurs from Holzmaden, which he was the first to describe, and of the marine Crocodilia from the Jura.

Among the most important of his early contributions were those to the Labyrinthodonts and other giant Stegocephalia of the Permian. Among his latest was the description of the carnivorous dinosaurs of the Trias as well as the geological narrative of the journey to East Africa. All his papers are enlivened by a keen appreciation of the importance of adaptation and of the adaptive significance of the various types of structure, one of his principal contributions in this line being his interpretation of the adaptive evolution of the ichthyosaurs from terrestrial to aquatic life, which was facilitated by the study of his unrivaled collections.

His death is a loss not only to the Fatherland but to the whole world of vertebrate pale-

ontology, for he was one of the most active and honored members of the new Society of Paleontologists which was recently formed in Germany.

His nature was most genial and those who had the privilege of journeying with him in the field will most keenly sorrow over his untimely death.

To the widow who is suffering this sudden and double bereavement all the friends and admirers of Eberhard Fraas in this country will extend their most heartfelt sympathy.

HENRY FAIRFIELD OSBORN

AMERICAN MUSEUM OF NATURAL HISTORY,
April 5, 1915

THE ROCKEFELLER FOUNDATION AND GENERAL GORGAS[1]

THE Rockefeller Foundation has invited General Gorgas to become a permanent member of its staff in the capacity of general adviser in matters relating to public sanitation and the control of epidemics. The trustees of the foundation have for some time been aware of General Gorgas's strong belief in the feasibility of completely eradicating yellow fever from the face of the earth.

During the two years of the foundation's existence the attention of the trustees has been chiefly given to problems of public health, including the control of epidemics and the need of a competent adviser and executive in this field has been strongly felt. When in cooperation with the American Red Cross the foundation undertook the important task of helping the Serbian government to control the epidemic of typhus and the threatened epidemic of cholera the trustees again naturally thought of General Gorgas as a man preeminently fit to be of service in this emergency, and at a meeting held in New York last week they decided to make him a definite offer. This offer is now taken under consideration, and he will doubtless communicate his decision within a few days.

The Foundation's invitation contemplates his retiring from active service, as he is now entitled to at any time, but it does not contemplate his resignation from the army unless he should be assigned to duties of such a nature as to be incompatible with the regulations affecting retired officers. Such a duty would be involved in his going to Serbia at the present time, which he could do as a representative of the Rockefeller Foundation, but not as an officer on the retired list of the army. The sanitary commission of the American Red Cross has actually been sent to Serbia in charge of Dr. Richard P. Strong, of the Harvard Medical School, as director. The Rockefeller Foundation is cooperating with the American Red Cross in the support of this expedition, and if General Gorgas should accept the Foundation's offer he will doubtless be largely influential in determining the nature and extent of its participation in the work.

In justice to General Gorgas, it should be stated that there is no foundation whatever for the statement that he is to receive a salary of $50,000. The offer of the Rockefeller Foundation includes a moderate salary and the assurance of the usual allowance in the event of resignation or death. If the offer proves attractive to General Gorgas it will be because of his sympathy with the general aims of the foundation in regard to public health and his belief that the resources placed at his disposal will enable him to render a large service to humanity along the lines of his professional experience and ambition.

[1] A statement made by Mr. Jerome D. Greene, secretary of the foundation.

SCIENTIFIC NOTES AND NEWS

AT the meeting of the American Philosophical Society, to be held at Philadelphia on April 22, 23 and 24, a long and important program of scientific papers will be presented. An account of the meeting, with abstracts of the papers, will be published in SCIENCE.

A TESTIMONIAL banquet will be tendered Dr. Abraham Jacobi by the medical profession, his friends and admirers, under the auspices of the Bronx Hospital and Dispensary, on May 6, at the Hotel Astor, on the occasion of the eighty-fifth anniversary of his birth.

THE honorary freedom of the Apothecaries' Company, London, has been conferred upon

Sir Ronald Ross, in recognition of the services rendered by him to medical science, especially in the prevention of tropical disease.

THE M. Salomonsen prize of about $200, awarded every fifth year at Copenhagen for some notable progress in the medical sciences, has this year been awarded to J. Fibiger for his work, "Animal-parasite Cancer in Rat Stomach."

AT the annual meeting of the Chemical Society, held on March 25, in London, the new officers elected were: *President*, Dr. Alexander Scott; *Vice-Presidents*, Professor F. R. Japp and Professor R. Threlfall; *Treasurer*, Dr. M. O. Forster; *Ordinary Members of Council*, Mr. D. L. Chapman, Professor F. G. Donnan, Mr. W. Macnab and Dr. J. F. Thorpe.

DR. EILHARD SCHULTZE, professor of zoology at Berlin, celebrated his seventy-fifth birthday on March 22.

PROFESSOR HIRSCHWALD, head of the department of geology and mineralogy in the Berlin Technical School, has been given the degree of doctor of engineering by the Technical School at Dantzig, on the occasion of his seventieth birthday.

REINHARD A. WETZEL, of the College of the City of New York, has been elected a member of the Deutsche Physikalische Gesellschaft, Berlin.

DR. CORNELIUS WILLIAMS, of St. Paul, has been appointed president of the newly established Minnesota State Health Bureau, and Dr. H. W. Hill, of Minneapolis, secretary.

THE Japanese government has applied to the Wistar Institute for the privilege of sending one of its medical officers to the institute to study neurology under Professor Donaldson.

DR. F. KØLPIN RAVN, professor of plant pathology at the Royal Landbohøjskolens, Copenhagen, Denmark, will come to this country during the first week in May and engage in a series of conferences with officials of the United States Department of Agriculture and of state experiment stations in the various states on problems concerned with cereal cultivation, particularly cereal diseases. He will be accompanied during his entire itinerary by one or more of the following men of the Office of Cereal Investigation: M. A. Carleton, C. E. Leighty, H. V. Harlan and H. B. Humphrey.

THE Royal Geographical Society's awards for 1915 have been made by the council and will be presented at the anniversary meeting on May 17. The Founder's Medal has been awarded to Sir Douglas Mawson for his conduct of the Australian Antarctic Expedition of 1911–14, which has achieved highly important results in several departments of science. The Patron's Medal has been awarded to Dr. Filippo de Filippi for his great expedition to the Karakoram and Eastern Turkestan in 1913–14. The Victoria Research Medal has been conferred upon Dr. Hugh Robert Mill, who for many years has done a great deal on behalf of geographical research. Other awards have been decided as follows: Murchison Award to Captain J. K. Davis, who commanded the S.Y. *Aurora* during the time of the Australian Antarctic Expedition, when he proved to be a seaman and commander of exceptional merit. Back Grant to Mr. C. W. Hobley, C.M.G., for his valuable contributions to the geology and ethnology of British East Africa. Cuthbert Peek Grant to Mr. A. Grant Ogilvie for the good work he has already done in geographical investigation and research. Gill Memorial to Colonel Hon. C. G. Bruce, M.V.O., who for 20 years has been exploring the Himalayas. The following resolution of the council has been accepted by the fellows of the society: "The council, having become aware that Sir Sven Hedin, a subject of a neutral state, has identified himself with the king's enemies by his actions and published statements, orders that his name be removed from the list of honorary corresponding members of the society."

DR. H. D. CURTIS, of the Lick Observatory, lectured before the faculty Science Association of Stanford University, on March 24, on "Some Recent Theories and Developments in Cosmogony."

PROFESSOR R. G. AITKEN, of the Lick Observatory, lectured before the Astronomical

Society of the Pacific in the Cabot Observatory, March 27, on "Globular Star Clusters."

Professor D. W. Johnson, of Columbia University, lectured on the "Physiography of Western Europe as a Factor in the War" before the Rochester Academy of Science on the evening of March 29; before a general convocation of the Case School of Applied Science in Cleveland on March 30; before a similar convocation of the students of Denison University at Granville on March 31; and before the annual meeting of the high school teachers of the state of Michigan at Ann Arbor on April 1.

The following lectures have been delivered under the auspices of the Syracuse University Chapter of Sigma Xi, during the second semester. On February 5, John A. Matthews, Ph.D., D.Sc., addressed a joint meeting of the Sigma Xi and the Archeological Society of Syracuse, on the subject of "Iron in Antiquity and To-day" and on March 5 Professor H. S. White, of Vassar College, addressed the chapter, students and public, taking as his subject "Mathematics in Nineteenth Century Science."

Dr. A. A. W. Hubrecht, professor of embryology at the University of Utrecht, died on March 21, in his sixty-fourth year.

UNIVERSITY AND EDUCATIONAL NEWS

Princeton University has received from Mrs. William Church Osborn $125,000 to establish the Dodge professorship of medieval history, and $100,000 from an anonymous giver to endow a professorship of economics.

The Schools of Mines, Engineering and Chemistry of Columbia University have received an anonymous gift of $30,000, to be applied to the reconstruction and new equipment of the laboratories of quantitative, organic and engineering chemistry in Havemeyer Hall. A gift of $20,000 is announced from Mrs. Samuel W. Bridgham, daughter of the later William C. Schermerhorn, who was a trustee of Columbia University from 1860 to 1903. An anonymous gift of $4,000 has been made for surgical research in the College of Physicians and Surgeons.

Mr. George W. Brackenridge has given to the University of Texas his yacht *Navidad,* valued at $100,000, to be assigned to the biological department of the institution. A preliminary survey of the Texas coast is to be made in the *Navidad,* starting from Port Lavaca.

The trustees of Emory University, Atlanta, which is being developed under the auspices of the Methodist-Episcopal Church, have agreed to take over the Atlanta Medical College as its medical department. For this department it is proposed that $250,000 be set aside as an endowment. The trustees have also agreed to erect a new teaching hospital near the medical school, to cost from $300,000 to $350,000.

The University of South Dakota has just completed the erection of a fire-proof chemistry building at a cost of $100,000. Dr. Alfred N. Cook is head of the department.

The new buildings of the Washington University Medical School will be dedicated with suitable ceremonies on April 29 and 30. Among those who will deliver addresses are Dr. Eugene L. Opie, dean of the medical school; Dr. William H. Welch, of Johns Hopkins University; President A. L. Lowell, of Harvard University; Dr. William C. Gorgas, surgeon general, United States army; Dr. William T. Porter, Dr. R. J. Perry, Dr. George Dock, Dr. Abraham Flexner and President Henry S. Pritchett, of the Carnegie Foundation for the Advancement of Teaching.

Dr. George Harrison Shull, botanical investigator at the Carnegie Station for Experimental Evolution, has been appointed professor of botany and genetics at Princeton University. Steps will be taken immediately to develop gardens, greenhouses and laboratories for his work at Princeton.

Dr. Raymond G. Osburn, assistant professor of zoology in Barnard College, Columbia University, has resigned to accept the professorship of biology in the Connecticut College for Women.

Dr. B. F. McGrath has resigned as a member of the staff of the Mayo Clinic, Rochester, Minn., and has accepted the position of di-

rector of the laboratories of pathological and surgical research in Marquette University, Wisconsin.

DR. HAROLD B. MYERS, Portland, formerly connected with the University and Bellevue Hospital Medical College of New York City, has become professor of materia medica and pharmacology, and Dr. Howard D. Haskins, Cleveland, formerly connected with Western Reserve University School of Medicine, professor of physiologic chemistry at the University of Oregon.

DR. H. ROY DEAN, professor of pathology in the University of Sheffield since 1912, has been appointed to the chair of pathology and pathological anatomy in the University of Manchester.

DISCUSSION AND CORRESPONDENCE

BOTANY IN AGRICULTURAL COLLEGES

IN SCIENCE for February 5, 1915, Professor C. V. Piper, of the United States Department of Agriculture, calls attention to botany in agricultural colleges. The article referred to directs attention to the previous article by Dr. E. B. Copeland on the same subject in SCIENCE for September 18, 1914. It would seem to be especially true that "this opens up discussion of a many-sided question of high pedagogical importance to agriculture." The articles, referred to above, have presented valuable views and the discussion ought to be continued, perhaps by those more able to do so than the writer. The present is desired to be taken as discussion rather than argument, and certainly not adverse argument.

Dr. Copeland apparently emphasized that "the raising of crops is essentially nothing more or less than applied botany." Professor Piper has forcefully presented the idea that "in striking contrast with chemists, botanists have shrunk from what may be a major application of their science, namely, that of crop production." It would seem that these writers might be on common ground in the belief that the problem of crop production must of necessity be solved with the attention of botanists.

It is possible that the writer may call attention to some difficulties of administration that are bound to exist in agricultural colleges, so long as the boundary lines are not clear between botany and applied botany and possibly agricultural botany, on the one hand, and agronomy and horticulture on the other.

If it be true, as Dr. Copeland suggests, "the raising of crops is nothing more or less than applied botany," then there is small need for agronomy as a collegiate subject.

If it be true, as per Professor Piper, that the whole field of plant culture, or crop production, being one of plant ecology and plant physiology, must be so recognized by botanists, before progress in crop production will continue, then likewise the future of agronomy, at least the crop side of it, must necessarily trust to the mercy of the conservative botanist.

What is agronomy?

Agronomy is the sum of information or of research directly concerning soils and crops grouped essentially in relation to the business of farming.

Agronomy may be called a science where it is understood that a science is a group of related facts, or, again, it may be called an applied science where it is understood that it has use for many kinds of information which may be drawn from pure science. But any effort to define agronomy as a pure science or to accomplish the work of agronomy by conforming it to any given pure science must result in confusion or in begging the question of agronomy entirely.

It is a perfectly logical question to ask whether agricultural colleges need to recognize any such subject as agronomy. It is perfectly logical to inquire whether the purposes of such colleges may not be better accomplished without any departments of agronomy. It is conceivable that the work of agronomy in all agricultural colleges and experiment stations might be accomplished, or at least attempted, through the efforts of the several departments of pure science, which severally furnish sources of information from which agronomy must constantly draw.

The organization of agronomy as a group of facts in agricultural colleges is thus not absolutely necessary. It is no more absolutely necessary to organize departments of agron-

omy to conduct instruction and research about soils and crops than it was originally necessary to organize agricultural colleges to educate farmers. The organization of agronomy is arbitrary, just as the entire matter of organizing agricultural colleges was arbitrary. The essential reason why agricultural colleges were organized was that the American people through their Congress conceived the idea that such colleges, if organized, would more definitely solve the problems of farm people and other industrial people than the old forms of colleges already organized. In short, colleges of agriculture and mechanic arts were to be and are logically organized, upon the basis of industrial needs, or else there was not and is not any call for any such separate organizations whatsoever.

It is matter of fact that colleges of agriculture and mechanic arts were and are organized, at least after a fashion, in the several states. Some of them appreciated fully that older institutions were concerning themselves with pure science and had been doing so for a long time and, further, they themselves were not brought into existence to be so many more of the same kind, but rather to make a very direct attack upon the problems of the farm and other industrial life. Those that saw that problem most clearly, it is safe to say, made the best progress.

In such institutions grew and are growing such forms of departments as agronomy, animal husbandry, horticulture, home economics, and dairy husbandry. The unit of every one is an industry, not a science. The organization of every one was necessary to solve the problems of an industry, not essentially the problems of pure science. The people and the departments, for example, who will solve the problems of soils and crops are agronomists and departments of agronomy. They will attack the problems from the standpoint of the business of farming and not from the standpoint of making application of some particular kind of science. It is true that they will need all the accurate information they can acquire from all fundamental sources. Their future departments will embody men whose equipment of knowledge consists in facts necessary to the solving of their peculiar problems. Such equipment of knowledge as they will have may not make them able to compete with specialists in any given pure science within the field of that science, nor will they expect to. They will have a business of their own. Agronomy can not and does not disregard pure science, but it has not and does not waste much time discussing whether pure scientists need more training. If they do, it is supposed that they will know that much for themselves, and in due time get it. The devotees of pure science will be busy enough withal, looking after their own proper fields of information and research, whether they be botany, chemistry or mathematics.

It is the function of pure science or of the several pure sciences to increase the sum of knowledge. Pure science departments in agricultural colleges are not properly different in that respect from pure science departments anywhere else. If they teach as they must, they should mainly supply that common basis for scientific thought which must needs be the common equipment of all who may engage in any kind of scientific work. If they engage in research, they should continue to develop and enlarge the world's knowledge, with primary regard for knowledge, not its application. In the agricultural colleges, the departments specially organized for the purpose will undertake to make application. Specifically the agronomists of the country are as well prepared to look after this their business of application, as botanists generally are prepared to supply new knowledge.

As Professor Piper has correctly intimated, the business of raising crops has made much progress upon the basis of knowledge secured by agronomists. Strangely enough, some of this knowledge has been "empirical." The process will continue. The way for botanists and botany departments in agricultural colleges to help will be to devote themselves to botany, not agronomy. Perhaps if they do that they will occupy the most enviable positions in the pure science of botany, and bring corresponding honor to their institutions. This will not be possible for them if they fuss around with the business of agronomy.

By such concentration of effort, and by such alone, can the departments of botany in agricultural colleges put themselves in position to answer the demands for botanical knowledge that will be made upon them. By such attention to plants, not as crops and as a part of an industry, but as part of a wide world's life, can they properly supplement the practical knowledge of departments of agronomy. By working separately and together, each in its well-defined sphere, can departments of botany and departments of agronomy in agricultural colleges contribute to the people and to the industry of agriculture, such science and such practise as will entitle their institutions to an honored place in future collegiate life.

A. N. Hume

South Dakota State College of Agriculture and Mechanic Arts

SOME NOTES ON ALBINISM

This journal has recently[1] briefly recorded some observation of albinos which recall some chance observations of the writer.

In the late "eighties" or early "nineties" when the English sparrow first became common and abundant near Franklin, Indiana, the writer, as a boy, was much impressed by seeing a white English sparrow. The albino, as well as two or more partial albinos, was repeatedly seen during the latter part of one summer in a large flock of the birds which lived about the barn on the home farm. During the same or a subsequent season there occurred one or more of the partial albinos in a large flock of the sparrows on an adjoining farm. Three or four years ago a female English sparrow pied on one wing and a portion of the back was frequently observed at Cold Spring Harbor.

Within two or three years of the time when the albino English sparrows were seen in Indiana a white fox squirrel was frequently seen in the same neighborhood. The writer saw it only once momentarily and at some distance, but other members of the family saw it and a brother examined it after it was shot by a neighbor. It was white except for the tail, which was characteristically gray. The writer is under the impression that he was told that the eyes were "red," but can not vouch for that statement, although it is apparently a fairly safe inference that they were pink.

Near Oswego, Indiana (in 1903 or 1904), was seen an albino robin. It was not a clean white, but was tinged a slightly brownish or dirty hue. The bird was clearly seen at fairly close range and its identification could not have been mistaken.

In 1909 a family of gray squirrels, attracted by the abundant supplies of nuts, etc., proffered them, nested in a tree in the yard near a house in the edge of the town of Marietta, Ohio. One of the squirrels, the male, was a complete albino. Three of the young were albinos and one was a normally pigmented individual. The mother was accidentally killed and the young died. The following season an albino young one was captured and was kept in captivity until maturity. It was a pure albino with white hair and characteristic pink eyes. In all to the present time there are said to have been eleven albino squirrels known in that locality.

In 1907 while collecting the common aquatic isopod, *Asellus communis*, in a spring stream at Arlington, Mass., I found a number of pure albinos. The albinos were fairly abundant, there being perhaps one albino to eight or ten of the normally pigmented individuals. In January, 1910, and again in 1911 albino *Asellus* were found at the same spring.

In a small artificial pond in the Catskill Mountains last October the writer saw what he confidently believes to have been an albino newt, *Diemyctylus viridescens*. The animal was near the edge of the pool and escaped into deep water. It could not be located on subsequent visits to the pond, only a portion of whose margin was readily accessible for observation. The individual was pairing when seen and was apparently a female. There were many newts in the pond, on some of which the black pigment was not very conspicuous, but this one appeared so distinctly a clear uniform light orange yellow that its identification as an albino seemed fairly safe. It appeared very much to resemble in general body color an albinic or xanthic specimen of

[1] O'Gara, January 1; Hargitt, February 12, 1915.

the salamander, *Spelerpes bilineatus*, recently kept for several months at this laboratory.

Arthur M. Banta

Station for Experimental Evolution,
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ALBINISM IN THE ENGLISH SPARROW

The notes on albinism in the English sparrow (*Passer domesticus*) appearing in Science of January 1 and February 12 suggest the desirability of placing on record certain similar observations made by the present writer. While residing in Chicago, from June, 1904, to May, 1908, I noted English sparrows showing partial albinism in the streets on many occasions. The extent of the white markings on these birds varied from a few feathers to perhaps a third or a fourth of the whole bird, no pure white individual being seen. The striking feature of the occurrence of these white marked birds was their abundance in the late summer and early fall of each year. At that season partial albinos were seen at least several times a week, sometimes daily for three or four days. By early spring these abnormal birds had disappeared; at any rate I have no notes regarding their observation at that time of the year. From these facts it would seem as though the numerous white-spotted birds seen in the fall were immatures of the previous summer. Also for some reason, perhaps connected with their conspicuous appearance, but few of them survived until the beginning of the following breeding season.

The common appearance of partial albinism in the English sparrow in a country where it has been recently introduced through human agency, as compared with the rarity of this phenomenon among most native birds, is suggestive of this being in some way an outcome of unusual conditions surrounding the species in its adopted home. In the absence of data regarding the sparrow in its native land, however, this is mere speculation.

Observations along the same line regarding another species of bird may have some significance. In southern California the Brewer blackbird (*Euphagus cyanocephalus*) has taken most kindly to the altered conditions brought about by settlement of the country, breeding in the shrubbery of parks and gardens, and feeding on the lawns throughout the towns. In Exposition Park, Los Angeles, the broad stretches of lawn have been particularly attractive to these grackles, and, especially in the fall, they gather here in large flocks. Partial albinism among these birds, just as with the English sparrows seen about Chicago, is of common occurrence in the late summer and fall, on several occasions two or even three white-spotted birds being in sight at the same time. The white areas of the birds observed were always of small size. None of these abnormal individuals has been noted in the spring. The question again suggests itself as to whether these grackles are not affected by something in the altered environment, the changed conditions having been obviously most favorable to the species and conducive to great increase in numbers.

In this connection, however, it is interesting to note that still another bird, the house finch (*Carpodacus mexicanus frontalis*), which has so adapted itself to urban conditions as practically to occupy in the towns of the southwest the position held elsewhere by the English sparrow, in all its vastly increased numbers shows no tendency toward albinism, at any rate no more than any other native bird.

H. S. Swarth

Museum of History, Science and Art,
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To the Editor of Science: On page 26 of the current volume of Science Mr. P. J. O'Gara asks for information regarding albinism among English sparrows. I have frequently seen nearly white specimens, especially in New York City, but never any that were entirely white. I believe that albinism occurs more frequently in this species than in any other, because the natural enemies that pick off the conspicuous individuals of other species do not dare to molest the sparrows in their close proximity to man. Thus individuals with albinistic tendencies are enabled to breed and these tendencies are transmitted to their offspring. Maunsell Schieffelin Crosby

TO THE EDITOR OF SCIENCE: In the issue of SCIENCE for January 1, there is a note by P. J. O'Gara on albinism in the English sparrow. As he asks for further observations I may say that I do not believe partial albinism is at all rare in the English sparrow. Although I have not recently observed any in this part of the country, some years ago, when living in Oregon, I used frequently to see English sparrows that were partial albinos associating with normal members of the same species.

F. L. WASHBURN

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WITH reference to Dr. O'Gara's note on the above subject in your issue of January 1, 1915, I may state that in England it is of comparatively common occurrence. Cases are frequently reported in the *Field* newspaper, and I have known of three examples myself. Partially white birds are by no means rare.

I also possess a specimen procured by my brother at Mosul in Asia Minor.

G. BATHURST HONY

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TO THE EDITOR OF SCIENCE: In your issue of January 1, Dr. P. J. O'Gara, of Salt Lake City, Utah, states that on several occasions last summer he saw a single female English sparrow (*Passer domesticus*) in the busy streets of Salt Lake City with a pure white plumage. He had never seen any reference to albinism in the English sparrow, and he asks if other observers have found this character to be common in that bird.

In reply, I may say that albino sparrows are fairly frequently seen in different parts of New Zealand. I have about 600 correspondents in the domain who send me notes on natural history, and I have received from them about a score of albino sparrows. These birds were first introduced into New Zealand in 1867, and now are the worst of all the bird pests. Albinism also is not unusual in the English blackbird (*Turdus merula*) in New Zealand; several complete albinos have been reported to me.

It is interesting to note that our native birds show a very marked tendency towards albinism. There are few species of native birds that do not show this tendency. It is very noticeable in the Kiwi (*Apteryx*), whose soft, fluffy plumage, when pure white, is surpassingly beautiful. Our native birds also have a tendency towards melanism, but this is not so marked as the albinistic characteristic.

JAS. DRUMMOND

CHRISTCHURCH, N. Z.

QUOTATIONS

AN ATTACK ON THE HEALTH LAW OF NEW YORK STATE

LAST week we commented briefly upon the first annual report of the New York State Public Health Council, congratulating our fellow citizens upon the results of the council's activities and upon the framing of a new sanitary code for the state. And even as we were penning the lines several bills were being introduced into the state legislature which, if adopted, would seriously cripple the work of the commissioner of health and nullify the new sanitary code.

These bills, fathered by Assemblyman Hinman of Albany, five in number, are in the shape of amendments to the public health law. The first (Int. 1561) is directed against the commissioner of health and instead of the present injunction that he "shall not engage in any occupation which would conflict with the performance of his official duties," orders that he "shall devote his entire time to the duties of his office." This is perhaps the least objectionable of the proposed amendments, apart from the insulting innuendo concealed in it, for the duties of the commissioner of health are so exacting as practically to demand his entire time in any case. The second bill (Int. 1600) will, if it becomes a law, seriously interfere with the sanitary work in the state, for it reduces the number of sanitary districts from a minimum of twenty to a maximum of ten, and at the same time fixes the salary of the sanitary supervisor of each district at a maximum of $2,500. In other words, it doubles

the labors of the sanitary supervisor and reduces his salary about 20 per cent. The third amendment (Int. 1601) makes permissive, instead of mandatory, the establishment of divisions in the State Department of Health and gives the commissioner the power to increase or decrease the number of these divisions, to consolidate them, or to change the name of any division at his pleasure. This is an altogether unnecessary interference with the existing law, and if it had any effect it would be in the line of decreased efficiency as making the divisions impermanent and liable to change at the whim of any one in power for the time being. The fourth amendment (Int. 1602) strips the Public Health Council of its power to define the qualifications of directors of divisions, sanitary supervisors, local health officers, and public health nurses hereafter appointed. The introducer's object in this amendment is not apparent, but the result of its enactment would inevitably be to open these appointments to unqualified persons and to create a number of jobs to be given in reward for political services. The fifth and worst of this series of bad bills (Int. 1603) would deprive the Public Health Council of the power to establish sanitary regulations, would delegate this to the legislature, and would even abolish the present sanitary code unless it shall be approved by the present legislature—and how much chance it would have of being approved by a legislature which had already adopted these amendments one can well imagine.

These, briefly stated, are the bills by the enactment of which it is proposed to impair the efficiency of the health department and to vitiate the work it has already accomplished. What may be the reason for the introduction of these bills it is difficult to understand. Their passage would not be in the interests of economy, for the worst of them, if passed, would not save the state a dollar, and others would rather increase the expenses of health administration by reducing the efficiency of the department, by putting the formulation of a new code in the hands of inexperts and of men ignorant of sanitary science, and by opening many of the most responsible positions to incompetents. No business can save money in that way. The entire appropriation asked for by the health department is only about $400,000—a paltry sum in comparison with the saving of lives and of dollars as well, which it is certain will result if the present law is let alone.

As a direct result of the work of the department during the past year there are two thousand persons, one thousand of them children, alive to-day in this state, outside of New York City, who would have been in their graves but for the efforts of Dr. Biggs and the Health Council. Are Mr. Hinman and his colleagues in the legislature willing to let these and three or four thousand others (for the life saving in public health work is cumulative) die next year in order to save thirty-five thousand dollars in the salaries of the sanitary supervisors who are to be dropped?

We can not believe the legislature will pass these reactionary amendments or, if it does, that the governor will sign them. But it will be better to spare both the legislature and the governor trouble by killing the bills in committee. This would doubtless be their fate if every physician would at once file his protest with the chairmen of the committees which now have the bills under consideration. In such protest the bills should be referred to by their introductory numbers and the protest should be addressed to the chairman of the respective committee as follows: Introduction Number 1561 (the first one above mentioned), Judiciary Committee, Assemblyman Frank B. Thorn, chairman; Int. 1600, Ways and Means Committee, Assemblyman Alexander Macdonald, chairman; Int. 1601, 1602 and 1603, Public Health Committee, Assemblyman Gilbert T. Seelye, chairman. We need not add that prompt action is needed to save the state from this threatened calamity.—*New York Medical Record.*

SCIENTIFIC BOOKS

Biology. By GARY N. CALKINS, professor of protozoology in Columbia University. New York, Henry Holt & Co. 1914. Pp. i–viii + 241. 101 figures.

This text-book is frankly based upon the well-known earlier work of Sedgwick and Wilson and follows it closely in subject-matter, method and illustrations. It is, however, even more strictly of the informational type and omits all reference to practical exercises or laboratory directions. The physiological side of the subject is emphasized. In the order of treatment the present work departs from the plan of its prototype and substitutes the logical course of proceeding from the simple forms to the complex, for the more practical one of introducing the student to the subject through contact with an organism of such size that it can be studied by the ordinary method of observation. For most teachers this would seem to be a change of doubtful expediency. While the fern and earthworm are still considered at some length, other types (*Ameba* and other Protozoa, *Hydra*, *Homarus*) receive as much attention. In each case, however, the particular form is studied in connection with some biological principle which it illustrates. The amoeba typifies the activities of one-celled animals; hydra, the nature of animals with tissues; the earthworm, the conditions developing where organ systems are present; the lobster, a more complex condition of organ systems involving the subject of homology. More briefly the nature of one-celled plants is treated in connection with yeast and bacteria; parasitism, as exhibited by *Tænia*, is discussed; and animal associations, adaptations against parasites, and the mechanism of immunity are appropriately presented. A series of these general subjects, including animal descent, evolution, conformity to type, somatic and germ plasm, and Mendelism, appears in the last chapter of the book, wherein the most recent work receives attention.

General biology is defined by the author as the science which deals with "the fundamental principles of living matter" and he then outlines specifically seven subdivisions which embrace practically the entire realms of morphology and physiology. That the recognition of such a subject as general biology is purely a matter of expediency is admitted when the author states that a thorough study of any one of the seven topics would compass the whole field. The purpose of general biology is, however, conceived to be that of forming a foundation upon which the other more specific subjects can be built. It is the thought of the author, and of others who write similar books, that students can be made acquainted with the main biological conceptions through a course designed for this specific purpose instead of acquiring the knowledge as a result of personal experience with many animals and plants. The large results of biological research are presented to the beginner before he is much acquainted with the varied materials manifesting the properties of living matter.

Whether this method is the best for use with an elementary class in the freshman or sophomore year of a college course is open to question. Much depends upon the circumstances in each institution. It may be said, in a general way, that the observational sciences won a place for themselves in the curriculum because they promised a training, through personal experience, that could not be obtained in subjects which are studied merely from books. Information comes thus as a result of discovery, and with knowledge comes training. Not only are facts gained but the method of their acquisition appears through repeated experience with concrete examples. The student is not told that the lobster has twenty somites in its body, but he is asked to discover for himself the number present in a certain specimen. He is not offered the generalization that all normal lobsters have the same number, but he is led to form this conclusion himself through opportunities for comparison with other representatives of the species and by means of the collective experiences of his fellow students. He is not told that there is a large group of branchiate arthropods characterized by this fundamental organization, but he is guided to the formation of such a conception by the observation that a considerable number of such animals, although differing in many other ways, presents a repetition of the same numerical condition. Experience, not authority, is the guide; the goal is a development of the power of accurate observation and the formation of judgments based upon such observations, not the acquisition of cer-

tain facts relating to a group of objects, known as plants and animals, as distinguished from other facts relating to non-living objects, or from still other facts concerning human activities in methods of expression or of living. The path of each student in his approach to this goal is his own, and it varies in infinite degrees from all others—no beaten track of conformity to text assures his arrival.

"But hold!" says the efficiency expert of the curriculum makers, "Will the student learn all about plants and animals in *the* course in biology, will he be able to identify and name those forms he comes in contact with, will he know about the nature of his own body and of his relation to other animals? We want the student thoroughly grounded in the principles of biology, so make a book and teach him these things. For this purpose you may have him for one twenty-fifth of his college course." And so there is much writing of books and the puzzled teacher tries first one and then the other. Something is the matter with each one, so finally he makes a book of his own. If he has decided that the efficiency expert of the curriculum makers *is* right and that a certain group of facts, presented to the students for their acceptance or rejection is the proper content of a course he emerges from his trials very comfortably and, educationally, lives happily ever after.

Of the numerous efforts to supply the demand for text-books which shall inform students regarding the principles of biology, that of Calkins is one of the most satisfactory. Doubtless, in his own laboratory, the book occupies a proper place in relation to the individual work of the student; but it probably would not be far from the truth to assume that, even under these favorable conditions, the element of individual effort is small. In the hands of the dependent teacher even this remnant would disappear. When a descriptive text is used it results, under the best conditions of laboratory work, in confirmation by the student of facts studied in the book; in the absence of proper laboratory opportunities the course based upon it becomes merely another informational subject and the test of its accomplishment purely one of memory. The distinction between the observational sciences and languages, history and other subjects presented on the basis of authority, largely disappears in the former alternative and entirely so in the latter. Undoubtedly the subject-matter of biology would well warrant its inclusion in a college course, but in the face of the opportunities for training students in making accurate observations, forming independent judgments and developing logical habits of thought—qualities that are always so much needed—how poor is the return! It is not to be denied that it is easier to inform students than it is to train them; it is not to be denied that there is a large popular demand that schools should instruct their students upon matters which will be of immediate "practical" use to them later. But it is the duty of schools to recognize that real education is training, and so to devise and administer their curricula as to provide this training, to the best advantage, for the various types of mind that are to be educated. In furthering this purpose the subject of biology offers unique and valuable opportunities to develop the powers of observation, comparison and judgment through personal experience with the scientific method. In view of the great significance of this method in our past achievements, and of its promise for the future betterment of society, it is encumbent upon teachers of those subjects, in which it is best emphasized, to insist that they be given time and opportunity to teach in ways calculated to render effective, to the largest degree, its operation in the activities of their students.

C. E. McClung

An Introduction to the Study of Fossils (Plants and Animals). By Hervey Woodburn Shimer. New York, The Macmillan Co. 1914.

In most sciences it is a remarkable year which does not produce at least one text-book, but paleontology has been taught in this country for eighty years before the appearance of this, the first strictly American elementary text-book of paleontology. Amos Eaton seems to have been the first American teacher to

present this subject to students, and, as a teacher, is only the grandfather or great-grandfather of the present generation, for James Hall was his pupil, and it is well known how many owe their training directly or indirectly to him. It is probable that few of the American paleontologists, excepting those who have graduated since 1900, received any formal instruction in paleontology, the general method being to set before the pupil a tray of fossils and the "Paleontology of New York," and await the, sometimes tardy, results of self-development. This meant, of course, a very long period of training, and the consequent discouragement of many who might otherwise have pursued the subject. This somewhat haphazard method was due, I believe, largely to the absence of any suitable text-book. These remarks do not, of course, refer to the vertebrate paleontologists who have in the main been zoologists, and who trace a very different and by no means parallel line of descent.

English text-books have been available and used to some extent. First Nicholson (1872, then at Toronto), later Nicholson and Lydecker (1889) were used, but these books were too compendious for introductory work, and have now long been out of date. Next came Wood's excellent little book (1893), now in its fourth edition, but this text covered only invertebrate paleontology and is much better adapted for the use of students in England than those in America. Finally came the English revision of Zittel's text-book (1900, 2d ed., 1913), which, though really a reference book, has been the background of the modern teaching of the subject in America. This book, valuable as it is, can not be placed in the hands of beginners, and all teachers will welcome the appearance of the present volume, a book which has been definitely planned to meet the needs of the novice, and which covers, in an elementary way, all branches of the subject.

The introduction of 28 pages is devoted largely to an excellent discussion of fossils and states of preservation. Personally, the reviewer regrets the appearance of the words fossilization and fossilized in this chapter. While these terms may be logically defined, they are seldom logically used, and, once set before a student, no amount of warning will prevent his use of them in a sense implying some alteration of the original substance.

Pages 29 to 82 contain a brief presentation of some of the more important facts concerning fossil plants. It would manifestly be impossible to write, in 55 pages, an introduction to the study of paleobotany, but the author has made a wise choice of the points of more general interest and includes as much as it is possible to use in an ordinary introductory course in paleontology.

The Invertebrata occupy pages 83 to 320. In this part of the book the author follows uniformly the plan of presenting first a somewhat complete description of a typical, if possible, modern, example of each important group, describing the morphology, physiology, and to some extent the habits of the particular animal discussed. Thus, under the protozoa, *Amœba proteus* is described as a type of the phylum, while at the other end of the section, in the phylum Arthropoda, *Cambarus* is described as a type of the class Crustacea, and *Triarthrus* as a type of the subclass Trilobita. Following the description of the type comes a general discussion of the group, relating particularly to those members found as fossils, and finally a brief description of some of the more important genera. Some paleontologists will doubtless criticize the amount of space devoted to the morphology and particularly the physiology of modern forms, but those of us who have to teach know that students rarely come to us with the kind of zoological training which would best fit them to take up paleontology, and to have in one book the zoology and paleontology will be of the utmost use to us.

Pages 321 to 402 contain the description of the Chordata, the cat being taken as a type of the Vertebrata. This part of the book is necessarily, from its briefness, somewhat less technical than the preceding part, but gives a good résumé of the important structural features of the various groups of vertebrates, and of the phylogenies of several families. It is usually found that this part of the subject is of much greater interest to the student and general public than any other part, and it is

to be regretted that the limits of the book did not allow a somewhat more expanded treatment, especially of the Reptilia and Primates.

On pages 403 to 406 one finds a brief bibliography of some of the more important books on subjects treated in the volume, and then follow three pages giving in tabular form the geological time scale and the geological ranges of the principal classes of plants and animals. The remaining 39 pages are devoted to an unusually full index and glossary.

The illustrations in the book deserve special mention. They are very numerous, and an unusually large number are original or redrawn for this work, and all are remarkably clear, well executed, and well reproduced. The figures of the echinoid, pages 167 and 168, may be particularly noted for their delicacy and clearness. Altogether the illustrations are better than those usually found in an elementary text-book.

A very useful feature is the practise throughout the book of giving the derivation of the generic and other group names. The questions, designed to direct laboratory work in connection with the text, will be of more or less value, according to the individual teacher. They serve as a review for the reader and draw attention to the important points in the descriptions. The book is of convenient size, the type good, and though certain paragraphs and the questions are set in another font from the main part of the text, the differences are not so great as to mar the appearance of the page, and are by no means comparable to the "fine print" of a generation ago.

As a text for an introductory course in paleontology the book strikes one as especially well balanced and well done. It will also be found extremely useful to the students of zoology and historical geology, and furnishes us with an answer to the question put so often to a geologist or paleontologist: "Where can I find a book about fossils which I can read without first studying paleontology?"

This review is not meant either as a eulogy or as a criticism of the book in hand, but the writer is aware that the text does contain some small slips, of the kind so peculiarly annoying to the author, but so difficult to detect in proof-reading. Most of these are small things which are either so obvious as to be without danger to the student, or things which would be apparent only to the specialist, and may easily be corrected in a later edition. One which might perplex the beginner is on page 352, where the Urodela are called Lizards. The others are almost all in the explanations of the figures.

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SPECIAL ARTICLES

ON THE LIFE OF ANIMALS WITH SUPPRESSED KIDNEY FUNCTION

Both clinical and laboratory observations agree in demonstrating that many of the so-called consequences of kidney disease are really nothing of the kind, but must be interpreted in some other fashion. Thus, the assumption that the edema sometimes found in patients suffering from kidney disease is the consequence of the disturbed kidney function lacks all support, for patients with complete suppression, or animals from which both kidneys are removed, do not show any consequent edema. In fact, such patients and animals steadily *lose* in weight unless special efforts are made to keep this up. Large, nephrectomized rabbits, for example, will lose some 50 grams per day before they succumb some four to eight days later.

In the same way that clinical experience and experiment have shown that the edema accompanying certain kidney disturbances is not to be regarded as a consequence of the loss of kidney function, they prove also that high blood pressure, cardiac hypertrophy, and the clinical manifestations of headache, stupor, coma, etc., so commonly regarded as "uremic" are not secondary to such loss of kidney function as so widely believed. The fact remains, however, that even though much revision is necessary in our interpretation of the signs and symptoms evidenced by victims of kidney disease, loss of kidney function is commonly regarded as incompatible with any prolonged continuance of life.

Why does man or an animal deprived of his

kidney function die? Since nephrectomized animals regularly show a progressive loss in weight, and since this is, in the main, only water, a first reason for death might reside in the gradual drying-out of the tissues. Whether the animal is fed or whether it is starved, a certain minimum of necessary chemical changes goes on, which continue, as long as the animal remains alive. A second reason for the death of the kidneyless animal resides, therefore, in the accumulation of metabolic products within the organism which normally are thrown off in the urine. A third reason for death (but one for which at present we lack every experimental proof) might reside in the loss of some internal secretion produced by the kidney and necessary for life of the organism as a whole.

The analysis of the conditions necessary for a proper exhibition of kidney activity would seem to indicate that it is the primary function of the kidney to secrete water. It secretes water in proportion to the amount brought it in a free state in the arterial blood stream. As this free water passes down the uriniferous tubules it leaches out of the cells bordering it and constituting the kidney parenchyma the dissolved substances which give urine its distinguishing characteristics (urea, ammonia, creatin, sugar, salts, etc.) which substances originally diffused into the kidney parenchyma from the blood stream.

If we ignore the matter of an internal secretion, these considerations, if correct, compel the conclusion that the kidney is of importance to the animal, first, because it is an organ through which water may be lost when present in amounts over and above those necessary to saturate the tissues (saturate the hydrophilic colloids); and second, because this loss of water makes possible the loss of certain dissolved substances which appear in even normal metabolism.

The steady loss of water in the ill or by a nephrectomized rabbit, for example, need not, of course, be an important element in the causation of death. Care in the administration of water by rectum or subcutaneously can overcome this. Nor is the inability to lose much water quickly, as by the kidney route, alone an insurmountable cause for death. Even under physiological conditions the human being not only can but does lose more water from the lungs and skin than through the kidneys. What is missing is the possibility of losing along with the water the various dissolved substances which appear as the products of metabolism. If this reasoning is sound it is to be expected that, other things being equal, *animals deprived of their kidney function should live the longer the better the possibilities of securing an adequate loss of dissolved substances along with their water elimination.* The facts bear this out. The furred animals, for example, which lose no water except through the lungs, after the kidneys are removed, survive this operation little more than four to eight days. The human species with its ability to sweat tolerates loss of kidney function some six to twelve days. James Taggart Priestley has reported the case of a patient who lived 22 days with complete suppression of urine. It is considerations of this kind that have prompted clinical workers to resort to sweating and catharsis by way of transferring to the skin and gastro-intestinal tract the functions which are ordinarily subserved by the kidney whenever this organ is pathologically affected. But even when advantage has been taken of such potentialities, the lives of patients with complete loss of urinary function have not been long.

It occurred to me that it ought to be possible to observe a greater span of life in animals after complete suppression of kidney function if only it were possible on the one hand to cover the needs for water absorption and water loss, while on the other, provision were made for an adequate loss of the products of metabolism which normally are leached out by the water which passes through the kidney.

Such conditions are satisfied in the case of the frog. Not only does the frog cover its daily needs for water (saturate its body colloids) by spending a part of its time in the water, but it also loses under the same circumstances the same group of materials which ordinarily give the urine its characteristic composition. The problem is similar to that in man, who loses the same dissolved substances in the sweat that

he loses in the urine, only in less amount. The frog does the whole more easily. When sitting in the water it not only absorbs water to supply its needs, but loses at the same time the non-volatile products of its daily metabolism (these diffuse into the water from the skin exactly as the same substances in the mammal diffuse from the kidney cells into the water running down the uriniferous tubules). As I have so frequently insisted, solutions are not absorbed or secretions given off "as such." While a secretion of water and of dissolved substances may occur in the same direction, they may quite as easily take opposite ones. These considerations make it apparent why on *a priori* grounds alone *the frog (and other amphibia) should be able to tolerate a loss of kidney function better than land animals.*

Experiment has justified the conclusion. I tried originally to bring proof in this direction by cutting the kidneys out of frogs. The operation is not only difficult, but fails because of the anatomical peculiarities which characterize the circulation in these animals. Since the venous blood returning from the legs passes through the kidneys, their excision is followed by an edema of the hind legs. To escape this effect and yet to exclude the external function of the kidneys, the ureters were therefore tied. Under aseptic precautions a series of frogs were operated upon through the flanks and the ureters isolated. They were tied with a first ligature close to the kidney and with a second as near the bladder as possible, the connecting segment of ureter being cut out. *These animals have now lived since January 8 of this year and are perfectly normal.*

My technical assistant, Josef Kupka, showed me how to keep these animals in excellent condition. They are housed in glass boxes heavily padded with moist moss. Inverted porcelain dishes with side openings permit them to hide. A shallow enamel pan always filled with fresh water is placed at one end of each cage. Every few days the frogs are fed live meal worms, which they devour ravenously. The wounds heal completely two weeks after the operation. At the present writing the animals thus operated are livelier and in better physical condition than the winter frogs comprising the stock from which they were chosen.

The kidneys of the frog after ureteral ligation seem to suffer but slight if any change. What has been observed will be discussed at another time.

These experiments prove that *frogs may live for weeks after complete suppression of external kidney function.* If the explanation of why this is possible in the frog is accepted as correct, it not only gives scientific support to long-established empirical clinical practises, but emphasizes the importance of a closer analysis of the conditions which may improve qualitatively or quantitatively the matter of absorption and secretion of water and absorption and secretion of food and the products of metabolism through the skin and bowel in the patient suffering from an inadequate kidney function.

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SOCIETIES AND ACADEMIES

THE CHICAGO ACADEMY OF SCIENCES

THE annual meeting of the Chicago Academy of Sciences, held January 12 at the Academy building in Lincoln Park, Chicago, was an occasion of special interest. The chief speaker was Dr. Albert A. Michelson, of the University of Chicago, who presented in simple, untechnical language the results of his remarkable studies on the rigidity of the earth. Dr. T. C. Chamberlin reviewed the history of the academy during the past eighteen years, during which time he had been president, and the following officers for the coming year were elected:

Professor John M. Coulter, President.
Professor Henry Crew, First Vice-president.
Dr. Stuart Weller, Second Vice-president.
Dr. Wallace W. Atwood, Secretary.
Mr. Henry S. Henschen, Treasurer.

Mr. LaVerne Noyes, president of the board of trustees, spoke encouragingly of the present and future work in the museum. Mr. Noyes is especially interested in the construction of habitat groups illustrating the natural history of Chicago and vicinity, and through his personal supervision and generosity a remarkable series of forty-one new groups was opened for inspection at the close of the business meeting. Dr. Wallace W. Atwood, of Harvard University, who has held the secretaryship of the academy during the last few years, and been associated with the academy boards in the or-

ganization of the museum and in the promotion of educational work, returned to Chicago to address this meeting on the "Progress of the Museum Work during the Past Year."

The "Celestial Sphere," which was recently installed in the Academy building, was open for inspection, and demonstrations were given at frequent intervals. In this apparatus all of the brighter stars which are ever visible from the Chicago region are represented in their appropriate places and with their appropriate magnitudes. By electrical power the sphere is rotated, so that the stars follow precisely similar courses to the apparent motion of the fixed stars in the heavens. In eleven and one half minutes the sphere completes one rotation.

The policy of the museum during the past few years has been to limit its new exhibits to those illustrating the natural history of the Chicago region. Thus the birds, mammals, insects, reptiles and flowers of Chicago and vicinity have been placed on exhibition. Every pains is taken and no expense spared to make these exhibits of the local material just as attractive as any that could be prepared. Each exhibit is arranged to bring out some feature in the life of the animal rather than to display the mounted specimen as dead. Each habitat group is based on field studies; the background is an enlarged and colored photograph taken in the field where the specimens were collected, and the foreground is so constructed that it blends imperceptibly into the painted background. The animals are either at play, in search of food, quarreling, caring for the young, or in course of flight. These exhibits have already proved to be of unusual educational value to the community, and they are being used regularly by the teachers in the public and private schools of Chicago.

The children's science library and free reading room was opened for inspection. About three hundred members and guests were present.

On the evening of January 15, the board of trustees gave a dinner in honor of LaVerne Noyes. This dinner was given as an expression of the hearty good fellowship in the board, and of the sincere appreciation of the generosity of Mr. Noyes in promoting the work of the academy. Mr. Henry S. Henschen presided as toastmaster. Professor T. C. Chamberlin, Professor John M. Coulter, Dr. Frances Dickinson and Dr. Wallace W. Atwood responded to toasts. At the close of the dinner the toastmaster presented a loving cup to Mr. Noyes on behalf of the board of trustees.

THE BIOLOGICAL SOCIETY OF WASHINGTON

THE 537th meeting of the society was held in the Assembly Hall of the Cosmos Club, Saturday, March 6, 1915, called to order by ex-President Stejneger at 8 P.M., with 60 persons present.

Under the heading Brief Notes, Professor A. S. Hitchcock called attention to the plans and methods of work in preparing a new Flora of the District of Columbia. It is hoped it will be completed within a year. It will contain analytical keys of all the higher plants found within a radius of fifteen miles of the city of Washington. It will not contain descriptions.

The first paper of the regular program was by J. W. Gidley, "Notes on the Possible Origin of the Bears." After the examination of much fossil and living material the speaker had arrived at the conclusion that the bears, constituting a small homogeneous, widely distributed group are not closely related to other living Carnivores. From a consideration of the tooth structure, the bones of the feet, and the basal cranial foramina, Mr. Gidley concluded that the bears were probably derived from the *Clænodon* group of the Creodonts, and that other living Carnivores were descended in part at least from the Miacidæ, a family of Creodonts not distantly related to the *Clænodon* group.

The second communication was by the sculptor, H. K. Bush-Brown, "The Evolution of the Horse." The speaker was present by special invitation of the president and introduced to the society by ex-President Stejneger. Mr. Bush-Brown discussed briefly the geological evolution of the horse, and then spoke at considerable length on the evolution of modern breeds of horses, particularly of he Arab and the effects of breeding it with other races, and its development in this country. His paper was well illustrated by lantern slides showing anatomical characteristics of various horses, as well as their external appearances.

On Thursday, March 11, 1915, at 8:30 P.M. the Biological Society of Washington held a joint meeting with the Washington Academy of Sciences in the Auditorium of the National Museum. Mr. Wilfred H. Osgood, of the Field Museum of Natural History and a member of the special commission for investigating the fur-seal question for the Department of Commerce during the summer of 1914, delivered a lecture illustrated by stereopticon and motion pictures on the fur seals and other animals of the Pribiloff Islands. All phases of the life of the seals on the islands, methods of killing, skinning, salting, etc., and

the introduced herds of reindeer, the Steller's sea-lions, and the native birds were shown in motion. About 350 persons were present.

M. W. Lyon, Jr.,
Recording Secretary

ANTHROPOLOGICAL SOCIETY OF WASHINGTON

At the 478th meeting of the society held December 1, 1914, in the Public Library, Dr. George S. Duncan delivered an address on "The Sumerian People and their Inscriptions." Their oldest inscriptions antedate 3,000 B.C., and the Enlil temple in Nippur dates back probably to 6,000 B.C. The Semites from Arabia conquered the Sumerians before 2,100 B.C. Of the Sumerian cities, only Lagash and Nippur have been thoroughly excavated. Scholars agree that the Sumerians were neither Semites nor Indo-Europeans, but were probably Mongolians. Their language was agglutinative. Their only garment was a rough woolen skirt. Various cereals were grown; also the date palm. There were many occupations, including weavers, smiths, boat-builders, jewelers and carvers in wood and ivory. There were priests, librarians, notaries, physicians, astronomers and musicians. The country was divided into city states ruled by kings. The age of Gudea, about 2,600 B.C., was one of high artistic development. The chief divinities were Anu, god of the sky, Enlil, god of the earth, and Enki, god of the water. Their religion was nature worship. The inscriptions consist mainly of historical records, laws, contracts, epics and religious texts. The tablets contain the oldest records of a paradise, a fall and a flood.

At the 480th meeting of the society, held January 5, 1915, in the Public Library, Dr. John R. Swanton read a paper on "Ethnologic Factors in International Competition." He showed that the factors which tend to disunion between human societies have been operative in all parts of the world and were probably necessary to the best development of the race. At the same time, the end of warfare may be confidently predicted from the constant increase in size and decrease in number of political units, from the progressive weaving of the world more closely together by means of transportation facilities and other means of communication, and because of the gradual international bankruptcy which war entails. A standing army goes with an aristocratic ruling class. There can be no permanent peace until exploitation of one nation or class by another ends.

At the 481st meeting of the society, held January 19, 1915, Prince Sarath Ghosh delivered an address on "The Ancient Civilization of India." The Aryans settled in India between 6,000 and 4,000 B.C. and there adopted agriculture, the beginning of civilization. Here also man passed from promiscuity to monogamy. The government was first patriarchal, then a republic, then an oligarchy, then a monarchy. With the latter began the caste system. Man first worshipped tools and weapons; later, nature. By 2,500 B.C. the Hindus worshipped a supreme deity and the language in the Vedas had reached its highest perfection. Deity was regarded in its gentler qualities as feminine. With religion began the arts and sciences. The age of life on the earth was estimated at four million years. An exalted code of warfare was evolved. By 600 B.C. Hindu civilization had reached its zenith. The Aryan invaders conquered the Turanian or Dravidian races they found in India and made of them subordinate castes. India taught the arts and religion from Java to Japan.

Daniel Folkmar,
Secretary

ACADEMY OF SCIENCE OF ST. LOUIS

At the meeting of March 15, Professor Nipher gave a brief account of work done in his laboratory. During the summer of 1914 he detected what appeared to be an effect of the fog-horn of a steamer on the magnetic field of the earth.[1] In his recent work a large bar magnet in a room containing an influence machine, and in contact with one terminal, served as a deflecting magnet upon a magnetic needle in an adjoining room. The deflecting effect of this magnet was balanced by another bar magnet, on the opposite side of the needle. The needle was made very sensitive by means of compensating magnets. A musical note from an organ pipe, operated by means of compressed air, produces effects precisely like those attributed to the fog-horn. Here also the effect is superposed on disturbances of the same order of magnitude due to other causes. Professor Nipher remarked that any disturbance of ionized air appears to be the origin of electro-magnetic waves in the ether. When we talk to each other in air ionized by solar radiation, we are perhaps sending wireless messages through the ether of space.

C. H. Danforth,
Recording Secretary

[1] Science, January 15, 1915.

SCIENCE

FRIDAY, APRIL 23, 1915

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

RADIO-ACTIVITY AND THE PERIODIC SYSTEM[1]

THE periodic system of the elements has for nearly half a century proved a most puzzling and absorbing problem to chemists. It has been called a law, but while there is undoubtedly an underlying law or laws, I doubt whether we have as yet any very clear conception of them. Certainly, the usual statement that the properties of the elements are periodic functions of their atomic weights was never strictly true, even in days of partial knowledge, and is much less true now. It was neither the periodicity "of the geometers," as Mendeleef himself said, nor the function of the mathematician. Indeed, we have now come to a view where, apparently, we must abandon the atomic weight as the only or even the chief determining variable.

The truth is that for many years after its announcement it was more truly a working hypothesis, and a great deal of work had to be and still has to be done before it can attain to its completed form. It contains much that is true, has been most useful as a guiding principle, and has shown a wonderful power of adjustment to new facts and increasing knowledge.

It was in 1895 that the system had to adjust itself to the first severe jolt which it received through the discovery of argon and helium, and three years later, of other inactive, monatomic elements. The necessity for readjustment here had been in part foreseen. The abrupt change in the progression of the elements from strongly electro-negative fluorine to strongly electro-

[1] Read before the Elisha Mitchell Scientific Society, March 9, 1915.

positive sodium, and, in general, the transition *per saltum* from period to period had been discussed by Reynolds and others. It needed explanation and was impossible mathematically except by passing through zero or infinity. Some, as Sedgwick and de Boisbaudran, seem to have predicted such transition elements, and when argon was discovered it was not difficult for Julius Thomsen and de Boisbaudran to arrange an entire zero group with approximate atomic weights three years before Ramsay's brilliant discovery of the other inactive gases.

There are other anomalies in the system which are difficult to explain with the accepted tabulation. Such, for instance, is the existence of the rare earths, now some sixteen in number, so closely alike chemically and so different from other chemical individuals. The more they are studied, the less possible does it seem to fit them in any vacant places in the table. Meyer has recently suggested that they may form a miniature periodic system in themselves reproducing the relations of the main system. But a more serious breakdown in the supposed fundamental principle of the system comes in the relative position of such elements as argon and potassium, cobalt and nickel, tellurium and iodine. After most exhaustive investigation of their atomic weights it has become evident that these can not be used in deciding the relative order and at the same time have these elements fall into the proper grouping with those elements chemically most nearly related to them. So the order of the atomic weights has been tacitly abandoned and the superior determining power of the chemical characteristics acknowledged. This can only mean that the mass of the atom is not the sole, nor indeed the chief, determining variable, and it would seem that the search for the latter can only be ended by the solution of the problem as to the nature of the atom itself.

Certain clews to this have undoubtedly been in our hands for a long time, but their leading was not clear and the thought of them baffling. Such, for instance, were the facts that by taking an atom of nitrogen and four of hydrogen a grouping of atoms was obtained which behaved in general as an atom and was the analogue of potassium. Or, again, carbon and nitrogen give us an analogue of chlorine—and so with compound radicals in general. But while both building and tearing down again were easy, they seemed to throw no light on how those we could not tear down were once built up.

Still another thought-inspiring fact which would seem to have important bearing on the nature of the atom and hence the meaning of the periodic system is the ease with which certain elements by a change of valence change their chemical character and form distinctive series of salts as if they had been transformed into different elements. This causes some confusion and what would ordinarily be called forcing in the present tabulation of the system, and it will be recalled that Mendeleeff, in his earlier tables, actually placed certain of the metals, as copper and mercury, in two different groups, assigning each two different places. Signs are seen in the work of Barbieri and others of a tendency to place certain of the elements in two or more different groups according to valence.

I believe that one should keep in mind the idea involved in Patterson-Muir's definition of an element as a collection or group of properties. Thus there are weight, electro-chemical nature, affinity, valence and other properties by which we recognize it and differentiate it from other elements and to which our knowledge of it is necessarily limited. There is a more or less defi-

nite gradation in these properties from element to element, showing an inter-relationship, and yet scarcely in itself justifying the conclusion that any one property determines the other or that they are dependent upon it. While it is true that it is hardly possible to dissociate these properties from some conception of matter, such conception has not yet reached its ultimate analysis and until it has we are dealing with the recognized properties alone.

In the same year in which the periodic system was forced to adjust itself to a zero group another discovery was entering upon its marvellous development which was to open up new views as to the nature of matter and radically affect the system. The remarkable and illuminating results obtained in the study of radioactive substances are paving the way for an understanding of the laws on which this system is based.

Radioactivity was regarded by Mme. Curie as an atomic property and this was the guiding thread which led to the discovery of radium. Of course. this preceded by a number of years Rutherford's announcement of his theory of successive transformation or the disintegration of the atom. It is a question whether the fact that an atom is undergoing disintegration is to be regarded as a property in the same sense as the mass, valence, etc., but so long as this change can not be induced, changed or stopped and is known to take place only in the case of a fraction of the elements it is certainly distinctive and may be called a property for lack of a better name. There is, however, undoubtedly a cause for this disintegration and this instability may be due to some inherent property of the atom.

At present there are some thirty-seven radioactive bodies known, with the possibility of still others being identified. Each has distinctive radioactive properties. For a number of these the chemical and physical properties are known. Each is an atom hitherto unknown and must be considered a new element. Of course, the present accepted arrangement of the periodic system does not provide for so many additional elements and indeed is rather hopeless for even the sixteen rare earth elements. What is to be done with this embarrassment of riches?

Soddy's study of the grouping in well-known families of a number of the better known radioactive elements according to their chemical properties, combined with a consideration of the kind of disintegration by which it was produced led him to a generalization which would enable one to place correctly any radioactive element whose source was known, and at the same time give an approximation as to its atomic weight.

Fajans arrived at the same generalization independently from an examination of the electro-chemical evidence, finding that the product of an α ray change was more electro-positive, while that of a β ray change was more electro-negative. Similar conclusions from various evidence were reached by Fleck and Russell.

The generalization is as follows:

When an α particle is expelled it carries with it two atomic charges of positive electricity and the expulsion of these two positive charges from the atom affects the valency of the product, as Fajans has pointed out, just as in ordinary electro-chemical changes of valency. If the atom were initially in Group IV., for example, its ion is tetravalent and carries four atomic charges of positive electricity. Two such charges having been expelled with the α particle, the product is in the di-valent Group II., non-separable from radium. The mass in this case is four units less. So with the β ray change. The β particle is a negative electron and the loss of this single atomic charge of negative electricity increases the positive valency of the product by one. Radium B, for example (in Group IV.), expels a β particle and becomes radium C (in Group V.). When-

ever two or more radio-elements fall in the same place in the Periodic Table, then, independently of all considerations as to the atomic mass the nature of the parent element, and the sequence of changes in which they result, the elements in question are chemically non-separable and identical. As will later appear, this identity extends also to most of the physical properties such as volatility and spectrum reactions.[2]

To express this "newly revealed complexity of matter," Soddy has suggested the word isotope. A group of two or more elements occupying the same place in the periodic table, differing in atomic weight yet chemically non-separable, is isotopic. There are possibly seven such elements isotopic with lead. Radium is one of four isotopes. The chemistry of thirty-seven radio-elements is thus reduced to a smaller number of about ten types.

Two fundamental changes in the old views as to the system are indicated here. First, the position of an element is not fixed but can be changed in either of two ways—by a change in valence (which, as is well known, can be brought about in various ways), and again by disintegration due to ray-emission. Secondly, more than one element can occupy a given position in the system. This is independent of the atomic weight, but such elements are chemically inseparable. This involves the giving up of all idea of the properties being functions of the atomic weights and necessitates the formulation of the law anew.

The place occupied by an atom is not solely determined by its mass but by its electrical content as well. According to Soddy, the system represents the chemical character of matter as the function of two variables instead of one. The electrical content is the essential variable in horizontal columns and mass is the essential in vertical columns.

It is somewhat early to raise the question as to whether all elemental atoms are the result of disintegration processes, or, conversely, of synthesis, but in any case the old puzzle remains as to their great irregularity in weight relations if the most accurate chemical determinations are to be relied upon. If the time should arrive when they could be calculated, chemists would naturally return to hydrogen as the standard. Certainly, at present these weights present no simple synthetic relations.

An explanation of this is perhaps at hand if the view of Soddy (and of Crookes at an earlier period and from a different standpoint) is accepted, namely, that in atomic weight determinations it is not a natural constant that is obtained but a mean value of non-homogeneous masses. In other words, the weight may represent the average of various isotopic atoms and not the absolute weight of identical atoms.

It is very fortunate that the simple expedient of arranging the elements in the order of their atomic weights could give the early workers so nearly correct a view of the periodic system. It would probably have remained hidden for a long time if this had not been so prominent a factor in determining the proper sequence. There is undoubtedly a proper sequence. This has been settled hitherto chiefly by consideration of the atomic weight, but also by examination into the relationship existing between the elements. For instance, the order of atomic weights would be iodine and then tellurium, but chemically tellurium belongs to Group VI. and iodine to Group VII. Therefore, the atomic weight order is reversed.

The sequence numbers of the elements, or atomic numbers as they are called, assume a new practical and theoretical importance. Within twenty years after the announcement of the periodic system, some,

[2] Soddy, "The Radio-elements and the Periodic Law," p. 6.

as Fedaroff, had sought to attach importance to these numbers, but the efforts had little to commend them. Lately it has been suggested by van den Broek that this is a fundamental and important number. Beginning with 1 for K, the numbers would be 2 for He, 3 for Li, 4 for Be, etc. The question then naturally arises, can these numbers be reliably determined without reference to the atomic weights and correcting the manifest mistakes made in following the simple order of these weights?

One method for doing so, though with limitations, lies in the measuring of the scattering of the α particles when passing through different kinds of matter. Geiger found that the angle of the scattering seemed to depend very largely upon the atomic weight of the scattering metal. A very small fraction are scattered through such a large angle that they return on the side of incidence. This deflection is, of course, both a volume and surface effect. For equal thickness of screen calculations based on Rutherford's conception of the atom and his belief that this large angle scattering is due to the near approach of the positively charged α particle to the positive nucleus of the atom of the screen would make the scattering vary as the product of the density by the atomic weight. Thus Rutherford calculated that the scattering by gold should be about fifty times that by aluminium. This has been confirmed by the experiments of Geiger and Marsden, and the relative scattering has been determined for a large number of elements. The phenomenon is manifestly one determined by the electrical content of the atom.

The nuclear charge of the Rutherford atom can be calculated from the α particle scattering at various angles. This charge is found to be one half the atomic weight multiplied by the charge of an electron. The same value was reached by Barkla by observations on X-rays. Soddy concludes that it is the nuclear charge rather than the atomic mass which fixes the position of the element, basing his conclusion largely upon the work of Barkla, Sadler and Moseley, which will be briefly outlined further on. This in reality agrees with the hypothesis of van den Broek that the number of electrons in an atom in the neutral state determines the place of the element if hydrogen has one electron and one nuclear unit charge, helium two electrons and two nuclear unit charges, etc.

The direct method then is a combination of the work of Bragg, Barkla and Sadler, and Moseley. Making use of the work of those first mentioned, Moseley photographed the spectra obtained by the cathode-ray bombardment of a number of elements, the X-rays thus produced being reflected and defined from a crystal face. The frequencies of the vibrations could be determined and this frequency was found proportional to the square of the atomic number. That is, there was a definite shifting in the direction of shorter wavelength in the spectrum of an element from that of the one next above it in the list.

The graphic representation of the system has never been satisfactory in spite of the many efforts to solve it. It is especially difficult to bring out the facts by any representation on a plane surface. The faults of the Mendeleeff table can readily be seen, and they make it very desirable to secure a better mode of expression. And yet it is difficult to use the three dimensions of space so that the average student can grasp the whole. Soddy's lemniscate curve certainly has its good points. This may be compared with the arrangement of Rydberg. It can not be claimed yet, however, that the law or laws underlying this system are known and well understood, and until such time a com-

plete and satisfactory graphic representation is scarcely to be expected. We can agree at least that progress is being made toward such an understanding.

FRANCIS P. VENABLE

SOME FALLACIES IN THE ARGUMENTS AGAINST FULL-TIME CLINICAL INSTRUCTION[1]

In a recent paper, published in SCIENCE, Dr. S. J. Meltzer comments upon two notable facts in connection with the present rather active agitation regarding full-time clinical instructors. The two facts singled out by him are: (1) The appointment of full-time professor of medicine, surgery and pediatrics, by the Johns Hopkins University, and (2) the disparagement of this type of plan by the council on medical education of the American Medical Association. Dr. Meltzer's paper itself constitutes a third notable fact, in that it represents one of the very few unqualifiedly strong appeals that have been made by a clinician in favor of full-time clinical instruction. Although engaged at present in a so-called fundamental research, the current of Dr. Meltzer's life has been clinical to so large a degree, that his conclusions can not be questioned on the ground of academic impracticability. He analyzes the report of the council with logical seriousness; and were it not for the artifice of a single italicized word, one would scarcely feel the flick of Meltzer's lash or realize the seriousness of the attempt of the council to laugh the case out of court. Dr. Meltzer, by rare grace and tact, forges an argument so uncommonly well tempered as to render supportive discussion almost unnecessary. And yet, if there be any force in the plea for full-time heads of clinical departments, it lies in the line of duty of those of us who are clinicians to develop its full strength by discussion.

In such a discussion, as indeed in all such discussions, nothing contributes so much to balance and rationality as does a proper conception of the historical perspective of the problem involved. It is essential to realize at the outset that the question is not a new one involving American medicine alone. Many men would have us believe that suddenly, as a result of this, that, or the other tendency, our clinical instruction in America has been found wanting, and that with typical American impulse we have set to moving in the sacred realm of education, the machinery of experiment. As early as the seventeenth century, Leibnitz attempted to justify his faith in quacks, on the basis that doctors were improperly trained as men of science, and that it was hopeless to look for the development of scientific teachings and methods in a practitioner, *der nichts thut als von einem Patientem zum andern rennen, und wenn er bey dem einen ist, auff den andern schon denket* (who does nothing but run from one patient to another and who, when he is visiting one patient, is already thinking about the next one). Almost a half century ago Billroth anticipated the Flexner report on Medical Education, in his "Ueber Lehren und Lernen," a work necessarily less modern in tone than Flexner's, less broad in the geographical consideration of the subject, but not a whit less emphatic in the assertion of corrective principles. Coming down to more modern times, we have the Report of the Royal Commission on University Education in London (1913) in which it is admitted that "the academic training received by medical students in London has not always been distinguished, and that the scientific spirit has been too often wanting." We in America have also found that, even in our best schools of instruction, the scientific spirit has been too often wanting, and we have found it wanting chiefly in the clinical branches. On this basis rests the agitation for full-time clinical instruction.

The phrase "full-time clinical instruction" signifies that the teaching of each major clinical subject be under the supervision of a properly qualified instructor, who shall serve as the head of his department, who shall devote all his energies during the working

[1] Read before the twenty-fifth annual meeting of the Association of the American Medical Colleges, Chicago, February 17, 1915.

school-day to the management of his department, who shall receive an adequate compensation for his highly specialized labor, and who shall be protected against the inevitable lures and enticements incident to his position, by a provision which denies him the right to accept private fees, or permits him to accept them only on such conditions as may be imposed by the university. This is the simple statement of the case. And as the question stands at present, its importance resides not in the working out of a detailed scheme of clinical instruction under such a plan;[2] but rather in formulating a critical judgment regarding the advisability and practicability of so modifying our method of clinical instruction as to make it conform to other approved methods of education.

And when we have said this we have hinted at one of the most paradoxically inexplicable phases of medical education. It may be stated that, almost without exception, *clinical* teachers realize the essential necessity for full-time men in all of the *fundamental* branches of medicine. The very canons of education demand such a system. Yet, a large number of these same clinical teachers assume that there is such a wide divergence between the teaching of the fundamentals and of clinical medicine, as to render wholly unwarrantable the conclusion that clinical teaching also should be based on that plan which alone is best suited for instruction in fundamentals. It is, for very self-evident reasons, natural that the scheme for full-time clinical instruction should have the strong support of most of the teachers of the fundamental branches. It is not so easy to explain the fact that opposition to the plan has come so largely from clinicians. Such a clean-cut division into camps is unfortunate, because it has set in motion a controversy tinctured with bitterness. The so-called laboratory men are charged with a tenacious hold on impractical ideals, limited by virtue of a narrow occupational horizon; and the clinicians are, in their turn, supposed to typify the old story, repeated in myriads of forms, of privilege clinging to tribute. Neither of these assumptions is entirely correct; both of them are essentially harmful because they drag the argument down to the low level of personalities. Disagreements of this sort usually rest on fallacious judgments. An unqualified advocate of the full-time clinical instructor, I have, for the past few years, noted various fallacies, patent or concealed, in the arguments against this plan of instruction; and the only object of this contribution is to examine these various fallacies, with the hope of clarifying a fairly well-confused topic.

Of all others, the fallacy most responsible for both bitterness and confusion is the assumption that full-time clinical instruction connotes a clean sweep, displacing all teachers who are private practitioners and replacing them by non-practitioners. Such a plan has the advocacy of no one. Barker, in his address on "Tendencies in Medical Education," falls into this particular fallacy when he develops the thought that "the present incumbents of clinical chairs" by virtue of "the rightfulness of the kind of work done by them" hold their positions in "good faith." He pleads the cause of these "honest, hard-working men" in such fashion as to warrant the inference that they are all to be displaced, and that their displacement is a breach of moral contract on the part of the university. Dr. Barker certainly does not, nor should any one else, minimize the value of such services as are rendered at Johns Hopkins University, for example, by those clinical men who are not on a full-time basis, simply because at that university there are academic heads to medicine, surgery and pediatrics. It is supremely important to recognize the fact that the varying character of clinical material will always make it both advisable and necessary for the university to offer place and preference to the properly qualified clinical teacher, irrespective to his affiliation with private practise. The full-time clinical instructor, together with his staff, is a necessary adjunct in organizing, coordinating and correlating

[2] Details of organization are purposely omitted, such, for example, as the number of full-time salaried assistants necessary to the successful conduct of a department.

the practical as well as the investigative work of his department, just exactly as the dean of a school is an adjunct in developing school spirit and school policy. The advocates of the full-time instructor should never, not even implicitly, subordinate the teaching value of the properly qualified private practitioner.

Even broader in scope is the fallacy that there is an important and essential variance of principle in teaching the clinical phenomena of disease, and in teaching function and structure or aberrations of both, in the laboratory. It is difficult to analyze this fallacy and at the same time avoid an undesirable discussion of the primary pedagogic principles involved in teaching medical students. It may be pardonable, however, to dip into abstractions just deeply enough to say that whether our efforts at teaching be confined to the fundamental or to the clinical branches, our aim is toward equipping our pupils to form proper judgments. If, as a result of their training, our students can affirm or deny conclusions, either by proper process of reasoning or by the direct comparison of objects to ideas, we may rest easy in the thought that the discipline of their medical education has been fruitful. And the process by which they should be taught to form proper judgments is exactly the same in the hospital ward as it is in the laboratory. In both places the student is taught to know certain fundamental truths, and from these he is taught to reason certain definite conclusions. The fact that in so many hospital wards and clinic rooms the student is taught *to know,* to the exclusion of being taught *to think,* is responsible, in large measure, for the fallacy that clinical teaching is, part and parcel, separate and distinct from fundamental teaching. If one doubts that clinical teachers err with hopeless frequency in this direction, let him pick up at random a number of clinical text-books and examine them critically. The conclusion will be unavoidable that preponderant stress and effort is laid on crowding the student with facts—on teaching him to know. One of the most recent clinical text-books states in its preface that the very best a teacher can hope to do is to teach his student to know.

This particular fallacy regarding the specific difference between fundamental and clinical teaching should not be dismissed by merely stating it. It is essential to expose the danger to which it leads. And this can be done no better than by quoting a sentence from last year's report of the Conference on Medical Education. This report states that

> Clinical teachers know that in the very nature of things the teaching of anatomy and pathology is in no way parallel to the teaching of medicine and surgery, because the teaching of medicine and surgery is inseparably associated with the practise of medicine and surgery.

This allows us absolutely no other alternative than the conclusion that anatomy and pathology are *not* inseparably associated with the practise of medicine and surgery. Surely the council can not hope that this conclusion will go unchallenged.

On the part of the clinicians there has always been a tendency to introduce this notion of the subtle, specific teaching value of private practise as a sort of abracadabra, charm, amulet, something to conjure with in the realm of medical education. They have studiously avoided the fact that the plan for full-time clinical instruction contemplates developing the principles of practise in their most utilizable form, namely from a variety of clinical material, intensively correlated and studied, and housed under one roof. Is there more to be learned of the basic traits of human nature on Fifth Avenue, or on Michigan Avenue, than there is in the wards of Bellevue or of Cook County Hospital? Or does the wealthy patient have a more legitimate demand on a larger share of the sympathy, interest, pity, or sweetness and light of his doctor's pervasive personality than does the helpless sufferer in the charity ward? The plan for full-time clinical instruction *does* contemplate the full realization of the intimate relationship between teaching medicine and practising medicine; what it does *not* contemplate is the injudicious mixture of private practise and teaching. And in this particular, the plan is strong against all

attack or argument, for the very reason that the majority of clinicians do not (and very properly do not) use their private patients as teaching material and could not even if they were so minded.

And all this leads up to another false assumption. It is argued that since from the standpoint of medical education, so little store is laid by a man's capacity to gain and hold the medical confidence of a large clientele, and to serve it intelligently and well, it necessarily follows that the rôle played by the private practitioner is less ennobling than that of his fellow who elects to be exclusively a clinical teacher. The practising physician very naturally resents such an inference. In reality, any conclusion which sets a comparatively lower value on the services of the private practitioner than on those of the exclusive clinical teacher, by reason of the fact that material remuneration is greater in one field than in the other, is a *non sequitur*. Certainly all thinking men realize that between the *spirit* of practise and the *spirit* of teaching there is no essential ethical difference. The value of effort in either field is directly proportional only to the grade of intelligence and purpose back of it. But between the *demands* of practise and the *demands* of teaching there is a variation so pronounced, qualitatively and quantitatively, as practically to preclude the proper performance of both these functions by the same individual. The full-time plan, therefore, rests upon this very rational conception of the case, and implies absolutely no measure of comparative worth between the vocations of practitioner and teacher.

In the teaching of such eminently practical branches as law, engineering, commercial chemistry, and other technical specialties, the need of the full-time instructor has been recognized and met. There seems to be nothing specifically so different in the practise of medicine as to demand that it be regarded as an exception in the general field of education. On the contrary, the teaching of clinical medicine demands the services of unattached men more urgently than does the teaching of any other practical art or science, because the two purely physical elements of time and fatigue enter so intimately into the problem. Barker has emphasized the overwhelming amount of correlated knowledge to be appropriated by the clinical teacher of to-day; an amount of data almost sufficient "to suffocate" him. This process of appropriation requires, in addition to intelligence, a very definite number of hours and minutes each day. An active practise rarely grants the necessary surplus of time. If, however, by a process of "speeding up," the practitioner succeeds in cleaning his slate, in order to fulfil his teaching obligations, he is very apt to find himself face to face with that other disturbing physical element—fatigue. It has always seemed a remarkable fact that the study of fatigue in its relation to efficiency should have been confined to the industries. We accept as true the fact that more than a given number of hours in his cab renders the locomotive engineer an unsafe person to differentiate between the two primary colors red and green; but we have to prove by argument that the busy surgeon can shoulder the enervating duties that confront him day and night, and still be fit for one of the keenest of all mental disciplines—the proper teaching of science.

And let us pause here just long enough to emphasize this word science in its relationship to clinical medicine. Not the least significant of the various fallacies that we are examining is the one that has to do with the thought that the fundamental man *must* be a specialist, and *must* be on a full-time basis because, although of course he is a teacher, he is also an investigator and must therefore have the necessary time for *scientific* research. By inference again we are subtly led to believe that scientific research is confined to anatomy or physiology or one of the other cognate fundamental branches of medicine, and that it need not be reckoned with in considering the teaching of the clinical branches. Those who favor the plan of full time clinical instruction are influenced in no small part by the hope that the properly qualified clinical teacher, favorably situated, will foster, stimulate and direct scientific clinical research of a higher order than is commonly produced under our present system of conducting clinical teaching. Clin-

ical investigation is, of all other types, probably the most intricate and difficult, for the reason that the problems studied are of such a nature that the factors entering into them can not, as a rule, be varied at the will of the investigator. If, therefore, we hope to encourage worthy product along the lines of scientific clinical research, we must, to say the least, provide the clinical teacher with an environment as favorable as the one with which we surround the fundamental teacher. It is no answer to this argument to quote the numerous examples of epochal discoveries made by busy practitioners. The superman will inevitably enrich his field, in the face of compromising odds or even of grueling adverse conditions. The problems of education always deal with averages, and what we desire to see is a system attuned to producing from among the common ranks of medical men a proportionately large number of clinical teachers and investigators.

We base our hopes on the full-time plan as an aid in attaining this worthy end, and all seems well until we are rudely halted by the oft-cited example of Germany, the nourishing mother of all that is best, and stable, and approved, in medical education. Germany has no full-time clinical instructors, and, what is more, the very men whom we all recognize as her leading clinical educators have not a particle of sympathy with the American full-time plan. Here truly is a stumbling block. And yet, the explanation is not as difficult as it appears to be. German clinical teachers, in spite of their unqualified rights to practise, have mortised themselves into medical history, so that their names fairly dot pages. More than that, practically every great German clinical teacher has developed about him a so-called school of younger men. By contrast, we have at home a proportionately very small number of names that even the most chauvinistic among us would set up with the leaders of German clinical thought, and only comparatively few of our clinical teachers have grouped a school of enthusiasts around them. But this contrast does not signify that the German clinical professor is efficient because of his uncompromised right to practise. At all events, it would be difficult to establish proof to this effect. It seems much more likely that he is efficient in spite of the fact that he shoulders the distractions of practise. Indeed, those who have come into intimate contact with the directing heads of clinical departments in Germany know that many of them resolutely set themselves against these distractions. Friedrich Mueller, of Munich, may be selected as a type. Mueller considers his two-hour *sprechstunde* devoted to private patients, as a type of relaxation, comparable to golf, mountain climbing, or other forms of diversion. No inducement will persuade him to lengthen the office hour, and he refuses to make extra-urban visits, under ordinary circumstances, unless there be some teaching value inherent in the call. His serious work is teaching and directing, to both of which he devotes consummate care, and consequently a large amount of time. Between Mueller as a teacher of medicine and, let us say, Marchand as a teacher of pathology, there is no essential difference. They are both so-called fundamental men, each in his own specialty; and Mueller represents the type that the advocates of full-time instruction in America hope to develop—the fundamental clinician as teacher.

If we be asked why we concede that private practise has not militated against the development of the highest type of clinical teacher in Germany and has so markedly militated against it in America as to call forth an edict of interdiction, we can answer only that the variance between German and American culture and traditions so profoundly influence thought and act as to render it impossible to graft, unaltered, a system of thought from one country to the other. It is likewise equally impossible to argue that because certain conditions are favorable from an educational point of view in one country, they must of necessity be favorable in the other. The German is the type of patient plodding lover of *gemuetlichkeit,* who, certainly up to recent times, did not labor in medical fields under a very heavy stress of commercial competition. Tradition requires that he advance to scientific preferment only through a dozentship, and this in turn implies approved excellence as teacher or producer. The American, on

the other hand, is the mercurial, restive type, who hasn't even a word in his vocabulary with which to translate *gemuetlichkeit,* and who labors medically in a strenuously competitive atmosphere. The essence of the matter is simply this, that up to now the German clinical professor has, as a rule, needed little or no protection against himself, whereas the American clinical professor has so frequently demonstrated the need of such protection as to call forth that forcible truth from Dr. E. P. Lyon, who characterized clinical professorial selfishness by the phrase "lying full length in the trough as he eats." If a sufficiently large number of American private practitioners had demonstrated their capacity to combine teaching and practise as the Germans combine them, there would probably be no call for the full-time clinical professor. They have failed to demonstrate this, and they can not explain that failure on the basis of German example.

Indeed, this failure on the part of the clinical teachers to teach as intensively as do the instructors in the fundamental branches is alone responsible for the agitation for the full-time clinical instructor. Whether they accept it or not, the burden of proof lies upon those who argue against a plan that attempts to do for clinical teaching exactly what has been recognized as essential in practically every other branch of education. For many of us it is difficult to see how the introduction of full-time clinical instruction can possibly fail to accomplish most of those things which we hope to see result from it, for all of us who are interested in seeing the reform meet with warm, broad support, there is much chagrin and disappointment in contemplating the half-hearted support and whole-hearted opposition accorded it. This chagrin and disappointment may be considerably tempered, however, if we bear in mind the truism spoken by President Lowell in his address before the New England Association of Colleges, last year. Said Mr. Lowell:

> Education is the last of all things to follow the stream of human thought and progress. It is still mainly in the deductiv stage.

If Mr. Lowell be correct in his statement, we may seek solace in the thought that we have at least an explanation for the fact that so many well-meaning clinical men experience difficulty in accepting an inductive syllogism the conclusion of which is "The teaching of clinical subjects should be under the guidance of exclusive clinical teachers."

MAJOR G. SEELIG
ST. LOUIS UNIVERSITY SCHOOL OF MEDICINE

CHARLES E. BESSEY

THE death of Professor Bessey removes a conspicuous figure from among the group of older American botanists. No botanist was better known personally among his colleagues. for he was eminently social, and enjoyed the various scientific meetings that brought his friends together. It is certain that no member of the botanical fraternity will be more missed at these meetings than Professor Bessey, for he was always the center and life of any group of which he happened to be a member.

The usual biographical data dealing with birth, training and official positions may be obtained from "American Men of Science," and need not be repeated here. The writer wishes to speak of him as an old acquaintance, and of his place in the history of American botany.

Professor Bessey first became known to botanists in general in connection with his position in the Iowa Agricultural College at Ames, and during his fourteen years (1870–84) of service there, his reputation as a botanist became established. In 1884 he began his long period of service at the University of Nebraska, where for thirty-one years (1884–1915) he was not only a commanding figure in his subject, but also in the university and in the state.

In the history of American botany, Professor Bessey stands for the introduction of a new epoch. Before 1880 the study of botany was practically bounded by the taxonomy of the higher plants, with such gross morphology as enabled the student to use a manual. In any event, the collecting and naming of plants was the chief botanical pursuit. For nearly thirty years before 1880, morphology as we understand it now had been developing in Germany, under the original stimulus given

by Hofmeister. The belated introduction of American students to this new field of botany was brought about by Professor Bessey, when in 1881 his "Botany" appeared. This volume not only brought the atmosphere of Sach's *Lehrbuch* to American colleges, but also compelled the development of botanical laboratories. For the first time, all plant groups became available, and cells and tissues became materials for study. The original "Botany" was the first of a long series of texts, and for many years "Bessey's text-books" set the standard for modern work. If Professor Bessey had made no other contribution to American botany than the publication of this book at the psychological moment, he would have made for himself an enduring place in the history of American botany.

The qualities that led him to discover and introduce to American colleges the new botany, also suggest that he was a great teacher. Perhaps no American botanist has left his mark on so many students as did Professor Bessey. He was certainly "apt to teach," and this was shown not merely by his neverfailing enthusiasm for his subject, but also by his stimulating companionship with his students. He lived in his subject and lived with his students, and his "dingy and cramped quarters," as they were called, seemed to cultivate the spirit of camaraderie in the whole department. The students of Professor Bessey are scattered everywhere in responsible positions, and the writer has never met one of them who has failed to pay the warmest tribute of loyal affection to the man who taught him.

Professor Bessey was not merely a great teacher, both through his text-books and in contact with his students, but he was also a public-spirited citizen. He felt that the whole state of Nebraska was entitled to his services, and he gave of his time freely to organizations of all kinds that were seeking to develop the various interests of the state. The plant life of the state, the agricultural possibilities of the state, the teaching of agriculture in the schools, all engaged his attention.

Recognition of Professor Bessey by his colleagues throughout the country came as a matter of course. He was not only a member of the various national organizations, but he was elected to almost every office to which an American botanist can aspire, culminating in the presidency of the American Association for the Advancement of Science. One of the characteristics of Professor Bessey most frequently remarked among his colleagues was his refusal to speak unkindly of any one. No one ever heard from him the sharp and occasionally envious criticism that too often mars the fine qualities of scientific men. Even in his work as a reviewer, where criticism is invited, he always searched for the pleasant things to say, and left the unpleasant things unsaid. Those of us who knew him best realize that he did not even think of the unpleasant things, but that his kindly nature was always seeing the good in every botanist.

Professor Bessey was a voluminous writer, as a man full of ideas, energy and of the teaching spirit is apt to be, so that it would be impossible to cite his bibliography here; it will doubtless appear in fitting form in some more appropriate connection. The present purpose is simply to express an appreciation of a great teacher of botany by a colleague who has known him intimately throughout almost his entire public career. JOHN M. COULTER

FRANK OLIN MARVIN

PROFESSOR FRANK OLIN MARVIN, dean of the school of engineering of the University of Kansas, died in San Diego, Calif., on February 6, 19155. Dean Marvin was born in Alfred Center, N. Y., in 1852. He was the son of Dr. James Marvin, for many years professor of mathematics in Alleghany College, and later chancellor of the University of Kansas.

Graduating in 1871 at Alleghany College, Professor Marvin devoted several years to practical engineering work. and was in 1875 appointed instructor in mathematics and physics at the University of Kansas. In 1883 he was appointed professor of civil engineering, and when, in 1891. the university was reorganized and a school of engineering was established he was elected to the position of dean. He was untiring in his labors for the upbuilding of this most important school, from this

time until 1912, when impaired health compelled him to retire from active work, although he was retained on the faculty as advisory dean. Last year he was granted a retiring allowance by the Carnegie Foundation.

It may be truthfully said that Dean Marvin devoted his life to the cause of engineering education. He worked and wrote for its advancement. In 1901 he was elected president of the Society for the Promotion of Engineering Education. He was one of the charter members, and the first president of the Kansas chapter of the Society of the Sigma Xi, one of the earliest chapters of this organization established. He was honored with the presidency of the national organization, and did much to shape the policy and raise the standard of this society.

As an active member of the American Association for the Advancement of Science (vice-president in 1896); of the American Society of Civil Engineers; of the Society on Testing Materials; Kansas Academy of Science; and as advisory member of the Kansas State Board of Health, he took an active part in the work for the encouragement of research and the advancement of scientific knowledge.

His colleagues in the university and the thousands of students who have been under his instruction, feel that a friend has gone. In the words of one of Dean Marvin's former students:

> He was further qualified for his work by his culture and refinement. No man was better fitted than Frank Marvin to plant in his boys the desire for the fine things of life. He was a reader, a student, an artist. Through all the busy years of striving and building, of creating great properties, or of humble service in some of the quieter places in life, Frank Marvin's boys look back to the school days of long ago and recall the quiet cultured gentleman who gave them so many ideals and who in his own life so lived these ideals.

The University of Kansas has honored the name of the first dean of its engineering school by naming the new engineering building "Marvin Hall," and the former students and friends are about to place in the building a bronze bust to commemorate his name.

LAWRENCE, KANS. E. H. S. BAILEY

THE CHEMICAL INDUSTRY IN GREAT BRITAIN

THE position and prospects of the British dye industry were discussed by Dr. W. H. Perkin, Waynflete professor of chemistry, Oxford, in his presidential address delivered on March 25 at the annual general meeting of the Chemical Society, London. Dr. Perkin is the son of the late Sir William Perkin, F.R.S., the discoverer of aniline dyes. "The Position of the Organic Chemical Industry" was the title of the lecture, and Dr. Perkin according to an abstract in the London *Times* at the outset expressed his conviction that the causes of the decadence of the industry in this country were still imperfectly understood. One of the main reasons for our present position was that we, as a nation, and our manufacturers in particular, had failed to understand the extreme complexity of the scientific basis of organic chemical industry. The decadence of the coal-tar industry and its gradual transference to Germany began during the period from 1870 to 1875. It was in 1874 that the works of Perkin and Sons at Greenford Green were sold to the firm of Brooke, Simpson and Spiller, and these works were then much in advance of anything that existed in Germany. One reason for the sale, Dr. Perkin said, was his father's natural dislike to an industrial career, and his desire to devote himself entirely to pure chemistry.

There was, however, a much more weighty consideration. It was recognized that the works could not be carried on successfully in competition with the rising industry in Germany unless a number of first-rate chemists could be obtained and employed in developing the existing processes, and more particularly in the all-important work of making new discoveries. Inquiries were made at many of the British universities in the hope of discovering young men trained in the methods of organic chemistry, but in vain.

The value of the coloring matter consumed in the United Kingdom was £2,000,000 per annum, and these dyes were essential to textile industries representing at least £200,000,000 a year and employing 1½ millions of workers, and

to many other industries such as the wall-paper, printing and paint industries requiring lakes and pigments.

In 1870, the time when this industry commenced to be transferred to Germany, organic chemistry was not recognized by our older universities, and the newer universities, which since then had done so much for the progress of science, did not exist. Many of our universities and particularly those of Oxford and Cambridge, and those in Scotland, contributed practically nothing to the advancement of organic chemistry in the latter part of last century, and even now their output of research was far less than it should be. In Germany, as soon as the importance of the subject became apparent, schools specially devoted to the subject were founded by such teachers as Liebig, Wöhler, Kekulé and Baeyer.

The president then dealt with the deficiency of dyes in this country, and referred to the schemes proposed by the government to ascertain the best means of obtaining sufficient supplies of chemical products. The grant of £100,000 which the government proposed to make to the company for research purposes would be better employed in subsidizing the research laboratories of those universities and colleges which were willing to specialize in organic chemistry, and to train a certain number of students with a view to their entering the services of the company. The existing dye works in this country compared very unfavorably, he said, with those in Germany, where experience had been in favor of building large works and against spreading manufacturing operations over small works situated in different parts of the country. Moreover, in the manufacture of any substance, by-products resulted which must be either recovered or used in the manufacture of other saleable products, and in order that these by-products might be used to the best advantage the dovetailing operations should be carried out on the same site, and thus save transporting the by-products from one works to another—an operation that must entail loss. The proposal of the government, therefore, to take over the existing works in this country appeared a doubtful policy.

INTERSTATE CONFERENCE ON CEREAL INVESTIGATIONS

THE undersigned committee on arrangements respectfully announce that on May 25–28, 1915, an Interstate Conference on Investigations of Cereals will be held in California. This proposed conference is the outgrowth of suggestion and expressed desires on the part of many investigators for a number of years that such a conference be held for the purpose of conferring on the various phases of all cereal research but particularly those more difficult problems concerning which there is difference of opinion, different methods of work, different points of attack and considerable variation in results, in order that these differences may be better understood by each other and that all such investigations be more coordinate and effective hereafter.

It seems that the fact that there are no other meetings at that time to conflict with this one and the fact that it is near harvest time in that region would be much in favor of having the conference at the time stated. It is realized that the time may be inopportune for some and that many in the eastern part of the United States will not be able to attend. It is hoped, however, that even of those in the east there may be certain ones who would in any case visit California about that time and who would avail themselves of the opportunity to take part in the conference. It is hoped and expected that there will be a good attendance from the territory west of the Mississippi River. A number have already signified their intention of being present and several have submitted titles of papers.

The arrangements are: To meet at Merced Tuesday, May 25, for a field inspection of the San Joaquin Valley cereals, go to Berkeley the evening of the same day and begin the conference proper the morning of the 26th at the University of California; continue the program the next day at the State Experiment Farm at Davis and finish the day with an inspection of the farm; then go to Chico in the evening or the next morning and visit the Plant Introduction Garden of the United States Department of Agriculture on the 28th. During the same day those who wish will go

by automobile to Biggs to inspect the Rice Experiment Farm at that place. That day will end the conference, after which the individual delegates will spend such other time and go to such other points within the state as they desire.

The following are proposed as general subjects for discussion, under each of which such subtopics may be discussed by different members as their inclination may dictate:

1. Problems of Pacific coast wheat production.
2. Improvement of barley for the Pacific coast.
3. Problems in cereal smuts.
4. Grading, milling, malting and baking.
5. Weed control in cereal production.
6. Tillage and crop rotation.
7. Insect enemies of cereals.

A program in detail will be issued later. It is expected that the discussions will cover a broad field. Millers, malsters and other dealers in grain, as well as agronomists, pathologists, chemists and entomologists are expected to attend. Among the foreign investigators expected to be present is Dr. F. Kølpin Ravn, professor of plant pathology at the Royal Landbohøjskolens, Copenhagen, Denmark. It is requested that each one expecting to attend make the fact known at once to some member of the committee. Titles of papers should be sent to M. A. Carleton, Department of Agriculture, Washington, D. C., and any other communications of inquiry concerning arrangements for meetings and other local information to Dr. J. W. Gilmore, University of California, Berkeley, Cal.

J. W. Gilmore,
M. A. Carleton,
F. S. Harris,
Ralph E. Smith,
F. D. Heald,
L. A. LeClerc,
F. M. Webster,
Committee

THE HARPSWELL LABORATORY

The Harpswell Laboratory, which has been maintained for several years at South Harpswell, Maine, as an institution of research, has been incorporated under the laws of Maine and has been placed in charge of a board of ten trustees. According to its charter, it is to be devoted to scientific study and investigation, while its constitution provides that institutions contributing funds to a specified amount will be entitled to appoint a trustee to represent its interests in the laboratory, the remaining trustees being elected annually by the corporation. The membership of the corporation includes those who have conducted investigations there and who have paid annual dues of one dollar for the current year.

Since its establishment, the laboratory has afforded facilities to 79 different individuals who have carried on investigations there. These have represented 43 institutions of learning. There have been published as based wholly or in part on investigations in this laboratory about sixty papers, making a total of about two thousand pages, illustrated by many figures and plates.

During the last season fourteen persons carried on research at the laboratory, these coming from Tufts College, Wellesley College, Wistar Institute, Johns Hopkins University, Northwestern University, Washington University and the University of Illinois. Their investigations covered: The exact homologies of the somites in the lower vertebrates, origin of taste-buds in Elasmobranchs, the nerves of the electric organs in skates, the morphology of the lungs and airsacs in birds, structure and functions of the ampullæ of *Lorenzini*, the development of the Piperaceæ, structure and development of the epiphysial organs of the dogfish, early development of *Clava*, development of liver and pancreas of *Acanthias*, the morphology of the hypophysis of Elasmobranchs and the skull of the dogfish.

The most important addition to the equipment for the year was a motor boat, 26 feet long with a two-cylinder, ten horse-power engine which puts all parts of Casco Bay within easy reach. The boat which had served for ten years was too small and had developed some of the infirmities of age. The library has been increased by several gifts and now contains over a thousand volumes and

pamphlets devoted to biology. It has several complete series of journals and some others of which only a few volumes are lacking.

The most imperative need of the laboratory is a new building capable of accommodating twenty investigators at one time, with a practically fireproof part for the library and valuable apparatus. Another necessity is a larger income. At present the laboratory is supported by subventions from several institutions. For several years the work has been carried on at an expenditure of less than $500 in any one year. Out of this small sum a collector has been employed, the absolutely essential supplies have been bought and some additions have been made each year to the permanent equipment.

During the coming season the laboratory will be open from about June 20 to September 10. It offers especial facilities for the embryology of the fishes and for experimental work on that most favorable material, the eggs of *Cerebratulus* and of *Echinarachnius*. The more northern fauna marks the laboratory off from similar institutions farther south, while the location assures one of a cool summer. No instruction is given, but the facilities are offered free to those competent to carry on investigations. All communications as to places in the laboratory as well as to accommodations in the town should be addressed to either Professor H. V. Neal, Tufts College, Mass., or to J. S. Kingsley, Urbana, Illinois.

SCIENTIFIC NOTES AND NEWS

Dr. J. George Adami, professor of pathology in McGill University, Montreal, has left for England to take up work as a member of the British War Office, having charge of the preparation of a medical history of the war.

Dr. S. Alfred Mitchell, formerly assistant professor of astronomy at Columbia University, and now director of the Leander McCormick Observatory at the University of Virginia, has been appointed Ernest Kempton Adams Research Fellow by the trustees of Columbia University.

Owing to the illness of Dr. Theobald Smith, the dinner which was to be given in his honor at the Harvard Club, Boston, on April 17, has been postponed until June.

The Medical Club of Philadelphia announces a reception to be given at the Bellevue-Stratford, on April 23, in honor of Edgar Fahs Smith, LL.D., provost of the University of Pennsylvania; Alba B. Johnson, Esq., for the president of Jefferson Medical College; David Milne, Esq., president of the Medico-Chirurgical College of Philadelphia, and Russel H. Conwell, D. D., president of Temple University.

Dr. Edmund B. Wilson, Da Costa professor of zoology at Columbia University, has been appointed by the trustees to be speaker at the opening exercises of the university, on September 22.

The van't Hoff fund committee of the Academy of Sciences of Amsterdam has awarded $120 to Dr. E. D. Tsakalotos, of Athens, in aid of his researches on the thermal properties, the viscosity and the magnetic susceptibility of binary mixtures, capable of yielding endothermic compounds.

The Academy of Sciences at Vienna has allowed $200 to Professor H. Dexler, of Prague, to aid in continuing his studies on stimulation of the brain cortex in the horse, and $150 to Dr. E. Pernkopf, of Vienna, to aid in his study of the development of the intestines and omentum.

Dr. George Sarton, editor of *Isis*, who was compelled to leave Belgium with his family on account of the war, has accepted a lectureship at George Washington University. Dr. Sarton will lecture on the history of science. At the close of the war, it is his intention to return to Belgium and resume the publication of *Isis*.

The Longstaff medal for 1915, of the Chemical Society, London, has been presented to Dr. M. O. Forster, F.R.S.

The Samuel D. Gross prize of the Philadelphia Academy of Medicine for the year 1915 has been awarded to Dr. John Lawrence Yates, of Milwaukee, for his essay entitled, "Surgery in the Treatment of Hodgkin's Disease." The amount of this prize is $1,500.

PROFESSOR W. WINTERNITZ, of Vienna, known as the founder of scientific hydrotherapy, celebrated his eightieth birthday on March 1.

PROFESSOR LILLIEN J. MARTIN, of Stanford University, has undertaken the chairmanship of the committee of the American Psychological Association appointed to arrange for and conduct the program of psychology to be held at San Francisco during the first week of August. The committee otherwise remains as previously announced, the additional members being Professors G. M. Stratton and Warner Brown, of the University of California.

DR. W. H. MANWARING, of Stanford University, has been appointed chairman of the pathological section of the National Association for the Study and Prevention of Tuberculosis, that will meet in Seattle, Wash., from June 14 to 16.

IN accordance with a provision in the annual Naval Appropriation bill, President Wilson has appointed an advisory committee on aeronautics. The purpose of the committee is to map out plans for stimulating aviation in the army and navy, and to adopt the best measures for overcoming the relative weakness of the United States military services in this field. The committee is composed of Brigadier-General George P. Scriven, chief signal officer, U. S. A.; Lieutenant-Colonel Samuel Reber, aviation section of the Army Signal Corps; Captain Mark L. Bristol, U. S. N., in charge of the Naval Aeronautic Service; Naval Constructor Holden C. Richardson, U. S. N.; Dr. Charles D. Walcott, secretary of the Smithsonian Institution; Charles F. Marvin, chief of the Weather Bureau; Dr. S. W. Stratton, chief of the Bureau of Standards; Byron R. Newton, assistant secretary of the Treasury; Professor W. F. Durand, of Stanford University; Professor Michael I. Pupin, of Columbia University; Professor John F. Hayford, of the College of Engineering, Northwestern University, and Professor Joseph S. Ames, of the Johns Hopkins University.

PROFESSOR G. D. HARRIS, of Cornell University, will repeat this summer the tour which he took last summer. The trip will be made in the motor-boat *Ecphora* and will cover approximately the same territory as last year. The party will leave Ithaca early in June and will consist of Professor Harris and the six or seven graduate students who intend to make geology their life work. The route chosen takes an inland course down the Atlantic coast, planned in such a way that the geologists can study the different rock systems of the geologic column. From Cayuga Lake the party will enter the Erie Canal *via* the Montezuma Canal, proceed to Albany and thence down the Hudson to New York, cross New Jersey by the New Brunswick Canal and reach Chesapeake Bay through the Delaware River and the Delaware-Chesapeake Canal. The last part of the journey will be a tour through the canals of the Dismal Swamp, and the trip will end in the vicinity of Wilmington, North Carolina.

DR. ALLEN W. FREEMAN, Richmond, Va., has resigned as assistant state health commissioner to become epidemiologist for the U. S. Public Health Service at Washington.

STUART P. MILLER, graduate assistant in the chemical department of the Massachusetts Agricultural College, has accepted an appointment with Parke, Davis and Company, of Detroit, Michigan.

A GENERAL meeting of the New York Academy of Sciences and its affiliated societies is announced for Monday, April 26, 1915, at the American Museum of Natural History. There will be a social hour, with refreshments, beginning at 9:30 P.M., preceded, at 8:15 P.M., by a lecture under the auspices of the Section of Astronomy, Physics and Chemistry, entitled "The Volcano Kilauea in Action," illustrated with lantern slides, by Dr. Arthur L. Day, director, Geophysical Laboratory, Carnegie Institution, Washington, D. C.

DR. VICTOR C. VAUGHAN, professor of hygiene and preventive medicine in the University of Michigan, Ann Arbor, delivered an address at a special meeting of the College of Physicians of Philadelphia, on April 12, on phases of modern military hygiene and camp sanitation, particularly in reference to war mortality.

Professor Douglas W. Johnson, of Columbia University, delivered an illustrated lecture on "Surface Features of Europe as a Factor in the War," at Johns Hopkins University on April 8. On the preceding evening he addressed the Harrisburg Natural History Society on "The Origin of Scenery in the Grand Canyon District."

On April 16 Mr. R. J. Hammond, chemist of the U. S. Bureau of Mines, lectured at the University of Illinois on "The Radium Industry in America."

Dr. A. J. Carlson, of the University of Chicago, spoke before six hundred students in physiology at the Ohio State University on April 9. He chose as his topic "Some Recent Contributions to the Physiology of the Stomach." Dr. Carlson summarized his investigations, giving especial attention to the cause of hunger pangs. This was the final lecture in the annual series offered by the department of physiology to its students. Professor Carlson will address a joint meeting of the Alpha Omega Alpha Chapter, of the Western Reserve Medical School and the Section of Experimental Medicine of the Cleveland Academy of Medicine on May 14 at the Medical Library on "Some Recent Contributions to the Physiology of the Stomach."

A stated meeting of the Geographic Society of Chicago was held on April 9, when a lecture was given by Mr. Charles W. Furlong, of Boston, Massachusetts, the title being "Chile and the Fuégian Archipelago."

Professor Arthur E. Haynes, who for eighteen years held the chair of mathematics at the University of Minnesota until his retirement in 1911, died on March 12, at the age of sixty-six years.

Dr. Ernest P. Magruder, of Washington, D. C., one of the physicians at the head of the American Red Cross unit in Serbia, has fallen a victim to typhus fever. For the last five years before going to Serbia Dr. Magruder had been professor of clinical surgery in Georgetown University.

The death is announced from Berlin of Professor Friedrich Loeffler, the distinguished pathologist, who in 1884 discovered the diphtheria bacillus. Dr. Loeffler was born on June 24, 1852.

Dr. Arthur Sheriden Lea, formerly university lecturer at Cambridge, known for his researches in physiological chemistry, died on March 23, at the age of sixty-one years.

Professor Georg Jochmann, of Berlin, has died from typhus fever, contracted in one of the camps for Russian prisoners.

Dr. August Volkenhauer, docent for geology in Göttingen, has been killed in the war.

The *Journal* of the American Medical Association records deaths among foreign students of the medical sciences as follows: A. Birnbacher, professor of ophthalmology at the University of Graz, aged 66, an authority on glaucoma in particular, but best known, perhaps, by his operation for ptosis and for cataract and his method of illumination of the eye; J. D. Pinero, professor of anatomy at the University of Buenos Aires and chief of the sanitary inspection service of the port and of the vaccine service, member of the national board of health and physician in chief at the hospital for men; J. G. Rueda, president of the board of health for the province of Cordoba, Argentina, governor, and member of the national senate, aged 53; G. Resinelli, professor of obstetrics at the University of Florence, aged 50; H. Apolant, a coworker with Ehrlich at Frankfurt, aged 48; Kreisarzt Filgenträger, of typhus contracted at the Langensalza camp of prisoners; Otto Markus, assistant at the Würzburg medical clinic, killed by a shell during the Argonne fighting. He leaves unfinished an important work on the histology of the ganglion cells of the nervous system.

The next annual meeting of the American Psychological Association is set for December 28, 29, 30, at Chicago, Ill.

Governor Whitman has signed the Walters bill, which appropriates $50,000 for the eradication of the foot and mouth disease.

Governor Fielder has signed the bill giving to the State Board of Health the power to grant to regularly incorporated colleges,

universities and philanthropic institutions in New Jersey permission to make experiments on animals under certain restrictions. The Rockefeller Foundation for Medical Research will now begin work on the construction of a laboratory near Princeton for the study of animal diseases. The ground, buildings and equipment of the new laboratory will cost, it is estimated, $1,000,000. As has already been announced, Dr. Theobald Smith, professor of comparative pathology at Harvard, will direct the institution.

WE learn from the *Journal* of the American Medical Association that the Langenbeck-Virchow building, the new home for the medical and surgical societies of Berlin, is on the point of completion. The library is already being moved into the new quarters. By combining several scattered medical libraries, it starts with 113,000 volumes.

ACCORDING to a cablegram from Nish, dated April 11, the British and French governments are sending large numbers of military surgeons into Serbia to fight the epidemic of typhus. Thirty English surgeons have already arrived. Fifty French physicians arrived on April 10 and fifty more are expected shortly, as well as a party sent out by the Rockefeller Foundation and the American Red Cross.

THE *Journal of Criminal Law and Criminology* is entering upon the publication of a series of monograph supplements which will be known as Criminal Science Monographs. The first monograph is now in the press. It will appear early next fall under the title "Pathological Swindling and Lying." Dr. William Healy, of Chicago, is the author. The volume will approximate two hundred pages. Each number in this series will be bound in cloth, and will come from the press of Little, Brown and Co., Boston, Massachusetts. Persons who have manuscripts in hand or in preparation, which they wish to have considered for publication in this series should communicate with Professor Robert H. Gault, Northwestern University, Evanston, Illinois.

THE Prussian department of education has petitioned the legislature for a continuance of the appropriation of 25,000 marks, which for six years has been granted for cancer research, on condition that private subscriptions would double the amount. This has always been done, and the private subscriptions are already assured for 1915. The appropriation is devoted mainly to the cancer research work being done under Professor Ehrlich's supervision.

AN institution for ethnological research has been founded in Leipzig. The new institution forms part of the King Friedrich August Foundation for Scientific Research. It is affiliated with the Ethnographic Museum of Leipzig, and is furthermore in close connection with the Ethnological Seminar at the university. Dr. Karl Weule, director of the museum, is also director of the research institution. It may be expected that excellent results will be obtained by this concentration of effort, which contrasts favorably with the dispersion of energy as found in cities like Vienna and St. Petersburg and in most cities of the United States.

UNIVERSITY AND EDUCATIONAL NEWS

HARVARD UNIVERSITY receives $100,000 by the will of James J. Myers, of Cambridge.

GIFTS amounting to $72,908, to be devoted to cancer research at the Harvard Medical School, are announced. The sum of $50,000 was provided by the will of Philip C. Lockwood.

BY the will of Mrs. Laura L. Ogden Whaling, of Cincinnati, Miami University receives $250,000 for a dormitory with $10,000 for its support. $10,000 is bequeathed to the alumni loan fund. The residue of the estate is to be divided between Miami University and the Cincinnati Museum Association, and it is said that each institution may receive $200,000.

THE Addison Brown collection of plants offered to Amherst College by Mrs. Brown in memory of her husband, at one time a member of the class of 1852, has now come into possession of the college. Containing many thousands of specimens collected in the United States, Mexico, Porto Rico, the Hawaiian Islands and elsewhere, it is by far the largest accession ever received by the department.

Plans have been drawn for the construction of four greenhouses, a heating plant, wells and windmills, and an underground piping system for irrigation purposes, on the new botanical garden for the department of botany of the University of Michigan. The old botanical garden east of the city with the 10,000 trees and shrubs which have been planted there, will be made into a tree and shrub park in about a year.

Dr. Henry C. Cowles, Dr. C. J. Chamberlain and Dr. O. W. Caldwell have been promoted to full professorships of botany at the University of Chicago.

Dr. Julius Stieglitz, professor of chemistry and director of analytical chemistry in the University of Chicago, has accepted an invitation to give courses in chemistry at the University of California during the summer term that begins June 21 and closes on August 1.

Professor Daniel Starch, of the University of Wisconsin, will give courses in educational psychology and educational measurements at the University of Washington, Seattle, during the coming summer session.

At the University of Birmingham Dr. Douglas Stanley has been appointed to the chair of therapeutics, and Dr. L. G. Parsons to a newly created lectureship in infant hygiene and diseases peculiar to children.

DISCUSSION AND CORRESPONDENCE

THE FUNDAMENTAL EQUATION OF DYNAMICS

The difference of opinion between Professor Huntington and myself is probably less than might be inferred from his recent communication.[1] I do not object to the use of the equation $F/F' = a/a'$, which indeed is a useful one. But it seems to me misleading to call this *the* fundamental equation of dynamics, because there is something equally fundamental that is quite independent of this equation—the fact that the *mass* of a body is one of the factors determining what acceleration it has under the action of a given force. The same fact is expressed by Professor Huntington in the words[2] "different bodies require different amounts of force to give them any specified acceleration," which he refers to as "this central fact of dynamics." My view is that this "central fact" should receive explicit and quantitative[3] statement in whatever equation or equations may be adopted for expressing the fundamental law of acceleration. The principle which such equations must express may be stated in different ways. In the review[4] which called forth Professor Huntington's comment I expressed the opinion that the method most intelligible to the beginner is to introduce at the outset the body-constant which was called by Newton *mass* or *quantity of matter*, and to make the fundamental principle a statement of the way in which the acceleration of a body depends quantitatively upon both the applied force and the mass of the body. The principle then takes the following form:

(*a*) *A force acting upon a body otherwise free would give it, at every instant, an acceleration proportional directly to the force and inversely to the mass of the body.*

The meaning is perhaps more clearly brought out by writing a definite proportion:

(*b*) *Forces F, F', acting upon bodies whose masses are m, m', cause accelerations a, a' such that*

$$\frac{a}{a'} = \frac{F}{F'} \cdot \frac{m'}{m}. \tag{1}$$

It is instructive to consider the following partial statements of the general principle:

(*c*) *If the same body is acted upon at different times by forces F, F' and if a, a' are the accelerations caused, then*

$$\frac{a}{a'} = \frac{F}{F'}. \tag{2}$$

[1] Science, February 5, 1915.

[2] These words seem to be a very definite corroboration of the statement (quoted with disapproval by Professor Huntington) that "an equation which results from comparing the effects of different forces *upon the same body* can not be regarded as a complete expression of the fundamental law of motion; it is equally important to compare the effects of forces *acting upon any different bodies*."

[3] The mere qualitative statement above quoted is no more satisfactory than the statement that "different forces acting at different times upon the same body cause different accelerations."

[4] Science, December 4, 1914.

(*d*) *If bodies whose masses are m, m′ are acted upon by equal forces, causing accelerations a, a′, then*

$$\frac{a}{a'} = \frac{m'}{m}. \tag{3}$$

(*e*) *If bodies whose masses are m, m′ are acted upon by forces F, F′ such that equal accelerations are caused, then*

$$\frac{F}{F'} = \frac{m}{m'}. \tag{4}$$

Equations (2), (3) and (4) are all particular cases of (1), but it requires two of them to express the whole import of (1), and there is no reason for regarding (2) as more fundamental or more important than (3) or (4). Any single equation which may properly be called *the* fundamental equation of dynamics must be equivalent in import to equation (1).

This does not mean that it is never allowable or advantageous to use the less general equations; on the contrary, problems and illustrations falling under these special cases are undoubtedly helpful to students. But the object should be to lead up to an understanding of the fully general principle expressed above in paragraphs (*a*) and (*b*) and in equation (1).

When this principle is fully understood, it is seen that equation (1) enables us to determine the acceleration of *any* body of known mass due to the action of *any* known force as soon as we know the acceleration of *one* body of known mass due to the action of *one* known force. For practical use it is advantageous to express the general equation in a more concise form. It is readily understood that (1) is equivalent to the equation

$$a = k\frac{F}{m}, \tag{5}$$

in which k is a constant of which the value depends upon the units chosen for expressing acceleration, force and mass; and that the still more concise form

$$a = \frac{F}{m} \tag{6}$$

results if units are so chosen that *unit force acting upon unit mass causes unit acceleration.*

The foregoing is essentially the Newtonian explanation of the second law of motion as interpreted by Thomson and Tait and accepted by other high authorities. In essential meaning there is no difference between this and the method advocated by Professor Huntington. The word mass is, indeed, avoided in his statement; but in recognizing the importance of the fact "that different bodies require different amounts of force to give them any specified acceleration" he recognizes the reality and fundamental importance of the body-constant which is usually designated as mass. By whatever name this constant may be called, it must play a part in the theory equivalent to that taken by mass in the equations given above. In Professor Huntington's presentation this part is taken by "standard weight," defined as the force required to give the body the acceleration 32.1740 ft./sec.[2] This does not conflict with the theory outlined above; in fact since the forces required to give different bodies a specified acceleration are by equation (4) proportional to their masses, standard weight as above defined may serve as a valid measure of mass. In explaining this method, however, it is important to make perfectly clear the fact that the quantity called standard weight is in reality the measure of a body-constant and is quite independent of gravity, in spite of the fact that it is given a name which is almost always associated with gravity. If properly safeguarded in this respect, Professor Huntington's method of developing fundamental principles is, I believe, logically defensible. Whether it meets the needs of beginners as well as that based upon the Newtonian treatment of mass may, however, be questioned.

To start with the notion of mass defined provisionally as "quantity of matter" has the same kind of advantage as starting with the "spring-balance" definition of force. Both definitions have a sufficiently definite meaning, gained from ordinary experience, to be of service in a preliminary explanation of the laws of motion. In comparing the masses of bodies composed of one homogeneous substance the significance of the words "quantity of matter" is indeed readily recognized, and it is distinctly helpful to generalize this notion even

though we must also recognize that any *general* method of comparing quantities of matter must employ either the laws of dynamics or some other physical law in which the same body-constant is significant.

Reflection upon what is really involved in the Newtonian laws soon shows, indeed, that the provisional definitions of force and mass are quite inadequate as a basis for a strictly logical explanation of the laws. It has long been recognized by writers who have attempted to formulate fundamental principles with full logical rigor that the definitions of both force and mass are implicitly involved in the laws of motion themselves.[5] An analysis of the strict logical import of the Newtonian system would, however, be quite unintelligible to beginners, and a recognition of the soundness of such an analysis is no reason for dispensing with the aid of the more tangible notions of *quantity of matter*[6] and *push or pull.*

While the method advocated by Professor Huntington is in my opinion sound in its essential features, the explanation of it in the paper[7] to which he refers seems to encourage the erroneous notion that the laws or facts of terrestrial gravity form a part of the principles of dynamics. Although the definition of standard weight quoted above is of course quite independent of gravity, in the paper it is given the form of a gravity definition: "The *standard weight* of a body is the force of gravity on that body in the standard locality." The reader is likely to miss the significance of the qualifying statement made elsewhere in the paper that the standard locality is any locality where g has the value 32.1740 ft./sec.^{2}—a statement which makes the reference to locality and to the force of gravity wholly irrelevant as regards the real meaning of the quantity called *standard weight.*

It is to be feared, also, that the definition of "force of gravity" given in the paper encourages vagueness rather than definiteness in the force concept. The conception of force as a *push* or *pull,* exemplified by the pull which stretches a spring, is a very definite one. It loses its definiteness, however, unless the fact is kept in mind that *there is always some body that does the pushing or pulling.* When, therefore, it is said that a body is acted upon by a certain force, it is always pertinent to ask *by what body this force is exerted.* How is this question to be answered in the case of the "force of gravity" as defined in the paper? The definition is as follows:

> By the "force of gravity" on a body, we mean simply the unseen[8] force which gives the body, when allowed to fall freely from rest, in vacuo, in the given locality, the observed acceleration g. It is equal and opposite to the force required to support the body in that locality.

The question *by what body this force of gravity is exerted* is not answered in the paper, and an attempt to supply the answer leads to the conclusion that the definition is inconsistent with the conception of force as *a push or pull exerted upon a body by another body.* The "observed acceleration g" has a component that is not due to force at all, but to the fact that our base for estimating acceleration is the rotating earth. The body is not acted upon by a push or pull that is "equal and opposite to the force required to support the body"; if it were, a supported body would have no acceleration, while in fact it has an

[5] Probably the most adequate formulation of the Newtonian laws from the point of view of strict logic is that given by W. H. Macaulay (*Bull. Am. Math. Soc.*, July, 1897). Mr. Macaulay's analysis makes it clear not only that the definitions of mass and force are implicitly contained in the laws themselves, but that the law of acceleration and the law of action and reaction can not be treated as independent, and further that the question of a base for estimating acceleration is of fundamental importance, since the laws, if true for one rigid base, will not be true for another which has any motion except a uniform translation with respect to the first.

[6] Professor Huntington's statement that the mass concept is "a derived concept, both historically and practically" is hardly true in any sense in which it is not also true of force. At all events mass in the sense of quantity of matter has been treated as fundamental by many high authorities from Newton down. See the opening paragraph of the "Principia."

[7] *Bull. S. P. E. E.*, June, 1913.

[8] Is the word "unseen" here intended to imply that there are forces which are visible?

acceleration even though at rest relatively to the earth.

Professor Huntington objects to the definition "force of gravity = attraction of the earth" on account of "complications connected with the spheroidal shape of the earth, the influence of the earth's rotation, etc." From what has been said above it is quite evident, however, that if the complications[9] connected with the earth's rotation are evaded by his definition it is only by a sacrifice of clearness in the force concept.

Clear thinking about the concept of force would seem to be promoted by the more usual method of distinguishing between *true* and *apparent* force of gravity; the former being the actual earth-pull on a body, the latter the pull or push exerted by a body upon its support. Each of these is a true force (a pull or push exerted by a specified body); to assume them equal is a first approximation to the truth. The reason they are not exactly equal can be explained rigorously when the student is in a position to understand the dynamics of circular motion; before that stage is reached it is sufficient to stop with the explanation which neglects the effect of the earth's rotation.

L. M. Hoskins

[9] The spheroidal shape of the earth introduces no complication whatever as regards the definition "force of gravity = attraction of the earth." It is not necessary to be able to compute the attraction in order to understand the definition.

THE NATURE OF THE ULTIMATE MAGNETIC PARTICLE

For many years scientists have agreed in ascribing the magnetic properties of bodies to the action of exceedingly small elementary magnets, but the nature of these ultimate magnetic particles has been an open question. The influence of temperature, chemical composition and other factors has received the simplest explanation on the theory that molecules, or possibly groups of molecules, are the ultimate magnetic particles. On the other hand the electron theory of magnetism, developed by Langevin, Curie, Weiss and others, seems logically sound and is the only theory which has successfully accounted for diamagnetism.

The recently developed method of determining the positions of atoms within a crystal by X-ray photography and the ferromagnetic properties of magnetite, hematite and pyrrhotite crystals suggested a direct experimental method of eliminating one or the other of these two theories. By comparing photographs taken through these crystals while magnetized and unmagnetized it can be determined with certainty whether or not the atoms have moved from their positions of equilibrium during the process of magnetization. We have obtained experimental results with magnetite and hematite which indicate that the atoms do not leave their positions of equilibrium during magnetization. These results are consistent with the electron theory of magnetism and prove conclusively that magnetism is not a molecular phenomenon.

K. T. Compton,
E. A. Trousdale

Reed College

THE NEW GLACIER PARK

To the Editor of Science: Referring to the pleasing intelligence communicated by Dr. John M. Clarke, in Science for March 12, relative to the new glacier park near Syracuse, a further note on the history of its investigation may well be added. It would seem that the earliest clear interpretation of the glacial stream channels about Jamesville came from a master of physiographic study who has strewn many seed thoughts by the way during the past forty years—Mr. G. K. Gilbert. The record is in "Old Tracks of Erian Drainage in Western New York," an abstract published in the *Bulletin* of the Geological Society of America, Vol. 8, 1897, pp. 285–286. Dr. Quereau's paper, which appeared in the *Bulletin* of the following year, cites Mr. Gilbert's interpretation by way of acknowledgment, and both papers have been followed by the full expositions of Professor Fairchild in the publications of the Geological Survey of New York.

Albert Perry Brigham

Colgate University

SCIENTIFIC BOOKS

A Monograph of the Molluscan Fauna of the Orthaulax Pugnax Zone of the Oligocene of Tampa, Florida. By WILLIAM HEALEY DALL, U. S. Nat. Mus., Bull. No. 90. Pp. xv, 173; Pl. 1–26. Jan. 21, 1915.

Collectors of curios and fossils alike have long known of the beautifully preserved specimens in the Tampa "silex beds" of Florida. But their chief interest, as the author of this monograph aptly remarks, "is not limited to their æsthetic beauty, nor their position as characteristic of one horizon in the series illustrating the evolution of life on the globe, but is of extreme importance as furnishing a key to the little-understood succession of the Tertiary beds which fringe the islands of the West Indies and the encircling continental shores of Mexico, Central America and northern South America. The Tertiary column of the coastal plain of the Gulf states being fairly well elucidated, the relative position of the deposits to the south can be determined if any one of them can be satisfactorily connected with a given horizon in the North American series. Such a connection is afforded by the fauna of the silex beds of Tampa."

This problem confronting the paleontologists of the New World is strictly analogous to that presented Mesozoic and Cenozoic workers in the Old, viz., correlating northern temperate faunas with widely differing ones of a more southern, tropical character. There, much progress is being made of late in the older Tertiaries by the use of organisms other than molluscan, especially Foraminifera, and a similar tendency will doubtless soon be shown in this country. Yet there, such forms as *Velates Schmiedelianus* have served well as indices of horizons in both the southern and northern provinces of Europe, and such characteristic types as *Orthaulax pugnax* are equally serviceable here, from the Panama Canal to Georgia. Incidentally we may note the author's attempt to designate other horizons by characteristic species, as, for example, in the upper Oligocene:

Zone of—	*Former designation—*
Scapharca dodona	Alum Bluff beds
Cardium cestum	Chipola marl
Orbitolites floridanus	Tampa limestone
Orthaulax pugnax	*Orthaulax* bed

It is certain that only by the study of such faunal zones we may ever hope to be able to correlate the widely scattered Tertiary deposits of the West Indies and Central America.

As regards the relations of the fauna of the *Orthaulax pugnax* zone Dall says:

Four species go back as far as the Claiborne sands, six are found in the Jackson Eocene, and seven in the Vicksburg. Eight come up from the *Lepidocyclina* zone, four have been recognized in the scanty fauna known from the Nummulitic zone, and one or two from the very imperfectly explored Chattahoochee fauna. Eight are known from the Tertiary of Santo Domingo, several of which are very characteristic of the zone. The two characteristic species of *Orthaulax* occur in the lower Oligocene of the Panama Canal Zone, and at least one of them has been obtained in Santo Domingo, Antigua, and Anguilla.

"Above the *Orthaulax* zone we find 51 of its species surviving in the *Cardium cestum* zone, but only 14 reach the zone of *Scapharca dodona*.

"Fifteen occur in extra-Floridian Miocene beds, but only three in the Floridian Miocene; 11 are found in the Pliocene of south Florida, and five in the Florida Pleistocene, while 23 survive in the recent fauna." Of the 312 molluscan species known from the *Orthaulax pugnax* zone, 90 are described in this monograph as new, while about 120 are refigured from the author's well-known Wagner Institute papers. More than half the remaining species described by various authors are discussed and re-figured.

Of special interest in this generally marine assemblage of species is the presence of 27 land and fresh-water forms, consisting, among others, of *Helix*-like, Bulimoid, Pupoid and *Planorbis* types. One new genus is described, viz., *Microcerion* "about midway between *Cerion* proper and the small Pupidæ."

No sympathetic regard for generic names

that have been in use for many decades has prevented the author from relegating them to oblivion if some other name seem to him to be the correct one in accordance with the strict rules of biologic nomenclature. For examples, note the following:

Strophia changed to *Cerion, Vermetus* to *Vermicularis, Utriculus* to *Retusa, Pleurotoma* to *Turris, Fulgur* to *Busycon, Eulima* to *Melanella, Astralium* to *Astraea, Crassatella* to *Crassatellites, Cylindrella* to *Urocoptis, Tornatina* to *Acteocina, Bulla* to *Bullaria, Turbinella* to *Xancus, Tritonidea* to *Cantharus, Sigaretus* to *Sinum, Pectunculus* to *Glycymeris, Lucina* to *Phacoides.*

Since the above changes are for the most part mere substitutions of a less well-known name for one in more general use, there can be no doubt that it becomes the most of us with less special training in molluscan nomenclature to follow Dr. Dall's lead in our future publications. However, in some instances the changes suggested are based on Bolten's publication, referred to as "Mus. Boltenianum, 1798," antedating Lamarck in "Prodrome" by one year; yet of that rare edition we have understood Dr. Dall to say that there are but four copies in existence, though recently Schorborn's republication (75 copies) renders the work more accessible to workers, at least in the vicinities of large libraries. To what extent the old masters were excusable for not possessing one out of perhaps a half dozen copies of a private work seems to us certainly a legitimate query. Nor does the number 75 strike us as rashly great in this early twentieth-century literature. The only change we sincerely regret is *Pectunculus* to *Glycymeris,* both names having become well established in the literature for very different types from those now proposed. However imperative the inexorable laws of biologic nomenclature may be as regards this matter, Blainville's use in "Man. Malac., Vol. I., p. 540, 1825, of the adjective *Phacoides* can not be regarded as furnishing a sound basis for "Genus PHACOIDES Blainville." However, so far as the undersigned is concerned, such matters are very secondary in importance to the many statements and suggestions regarding matters of correlation and evolution. Note the artificiality of certain generic terms as brought out in Dall's discussion of the species *Vellorita floridana.* He says: "this fossil has the conchological features of the recent species, the *V. cyprinoides* of Asia, but the combination is one which is probably due to dynamic causes operating upon a species of *Cyrena,* and which might occur sporadically anywhere within the distribution of the genus *Cyrena.* The Asiatic or African forms have probably no more intimate connection with the American fossils than that thus indicated, and the same is true of the fossil *Batissa* from the Puget group and its South Sea analogues. The 'genus' *Hinnites* is another form in which it is unlikely that there is any genetic connection between the species occurring in different horizons except what is furnished by the genus *Pecten,* from which *Hinnites* species are probably mere sports."

Extremely valuable as a connecting link between the Jackson and Vicksburg forerunners and the Recent *Busycons* is the new species figured as *B. stellatum* (Pl. 10, Figs. 7, 9). Noteworthy from a lithologic standpoint is the statement that silicification of the calcareous matter of the fossils exposed between tides is now going on. We heartily agree with the author in his dislike of the present usage of the term "formation." We have never understood why the taxonomy of geologic units should be other than that suggested by the International Geol. Congress, '89, *i. e.,* Group, System, Series, Stage, with corresponding time units, Era, Period, Epoch and Age. Finally, as an interesting matter in methods, of illustration, we have a chance to see in this monograph in juxtaposition some excellent pen-and-ink drawings by McConnell and the results of modern photographic methods in use by the U. S. Geological Survey. The latter are good, though sometimes showing a lack on the part of the artist of the finer essential features of the shell. This monograph must be regarded as a distinct and valu-

able contribution by America's foremost student of Cenozoic invertebrate paleontology.

G. D. Harris

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Text-book of Physiological Chemistry. By Olof Hammarsten. Translation by John A. Mandel. Seventh edition. Wiley and Sons, New York.

Another edition of Hammarsten's "Text-book of Physiological Chemistry" is now available in English (translation by Mandel).

Outside of the material contained in the first two chapters of the last edition which now have been combined into one, the arrangement of the older editions has been retained. Chapter for chapter, almost every subject treated occupies very nearly the same number of pages as before. Nevertheless, this edition is far from being a mere reprint. The newer observations and references are usually to be found—sometimes in place of older observations (and references), but more frequently as additions. In the field of metabolism, a field always somewhat scattered and submerged in "Hammarsten," the new edition will prove disappointing to American students just as the older editions have been. Most of the facts are there, but it takes a brave and diligent student to find them.

The index is very full, but its usefulness to students is not so great as it might be because it still lacks expert systematization. The first subject that the reviewer happened to look up in the index was mucin; sixteen references are given, the first is entirely misleading and the most essential references are tucked away in the middle of the long list.

Index and all, however, American biochemists are always pleased to see one more edition of the book which more than any other is kept within reach for daily consultation.

Otto Folin

NOTES ON ENTOMOLOGY

Two recent parts of Das Tierreich treating of the hymenopterous superfamily Proctotrypoidea[1] are almost monographic in character. Both are by the Abbey J. J. Kieffer and treat of almost 1,800 species in over 180 genera. An illustration is given of nearly every genus, and there is an introductory portion treating of the external morphology. Many of the species are from our country.

India is sufficiently distant from both Europe and America and its fauna has been sufficiently unknown to have been selected as the probable place of origin of many types of animals. Its insect fauna, however, is now becoming better known through numerous books; three have come to hand recently. One by T. B. Fletcher[2] deals with the insects of southern India. There is an introductory account of insects, and life histories of many species representing most of the families. A second large work is by E. P. Stebbing[3] and is devoted to accounts of the life history of and the damage wrought by the forest beetles of India. Unfortunately it contains the descriptions of various new species. The third work is purely economic and treats of the pests of various crops.[4] It consists of 84 leaflets with plates, mostly colored, of insect and fungous enemies of field crops.

Several microlepidopterists had shown that certain Tineid larvæ are of different shape and habit at different stages of development. Trågårdh[5] has investigated these forms and arranges them in two sections, the tissue eaters that bite and eat the parenchyma of the leaf, and the sap-feeders, that take only liquid. The former method is the more primitive, the

1 Lief. 41, Bethylidæ, 595 pp., 205 figs.; Lief. 42, Serphidæ and Calliceratidæ, 254 pp., 103 figs., 1914.

2 "Some South Indian Insects," Madras, 1914, 565 pp., 440 figs., 50 pls.

3 "Indian Forest Insects of Economic Importance—Coleoptera," London, 1914; 648 pp., many pls. and text figures.

4 "Crop Pest Handbook for Behar and Orissa," Calcutta, 1913. Issued by Dept. of Agric. of these provinces.

5 "Contributions Towards the Comparative Morphology of the Trophi of the Lepiodopterous Leaf-miners," *Arkiv Zoologi*, VIII., No. 9, 48 pp., 62 figs., 1915.

latter requiring special modifications of the mouth parts. Several species are sap-feeders when young, and in later stages become tissue feeders.

The first impulse, upon finding some strange new form of insect, seems expressible only in a new ordinal name. Dr. Silvestri has found some small forms (2 mm. long) in Africa and Malasia representing the newest order of insects, Zoraptera.[6] The genus *Zorotypus* is based upon several species resembling young Gryllidæ. They have enlarged hind femora, two jointed tarsi, head with distinct Y mark, no eyes, last joint of palpi enlarged, nine-jointed antennæ, and short one-jointed cerci.

It is indeed refreshing to find a paper on the systematics of Culicidæ that contains no new generic names. Mr. E. Brunnetti[7] has studied the proposed genera of mosquitoes from the standpoint of the dipterologist and comes to the conclusion of Dr. Williston that most of these names are based on characters of no generic value in Diptera, and are therefore synonyms. Under *Culex* he places no less than 72 such names. The value of the various characters is considered, and tables are given to the vaild genera; some names, however, still left in doubt. *Corethra* is regarded as forming a subfamily in the Culicidæ.

We all know that an insect "bite" is not simply a puncture, but our first interest has been to find a remedy. Dr. J. H. Stokes[8] however, has investigated the pathological and histological features of a "bite" and concludes, that, irrespective of pathogenic organisms, the insect introduces a toxic agent which produces considerable changes in the tissues near the "bite." This toxic agent is not injured by alcohol nor by dry heat, but is inert after treatment with hydrochloric acid. The history of a "bite" is divided into four stages; the papular, the pseudovesicular, the vesicular or oozing stage, and the involution or subsidence.

N. Banks

[6] "Descrizione di un nuovo ordine di insetti," *Bol. Lab. Zool. Gen. Agrar.*, VII., pp. 193–209, 1914.

[7] "Critical Review of 'Genera' in Culicidæ," *Rec. Ind. Mus.*, X., pp. 15–79, 1914.

[8] "A Clinical, Pathological and Experimental Study of Lesions Produced by the Bite of the Black Fly (*Simulium venustum*)," *Jour. Cutan Diseases*, November and December, 1914, pp. 46.

SPECIAL ARTICLES

A CASE OF ASSUMPTION OF MALE SECONDARY SEX CHARACTERS BY A COW[1]

A pure-bred registered Ayrshire cow, named Dorothy of Orono (23010), belonging to the University of Maine, produced three calves, on dates as follows: September 17, 1909, September 10, 1910, February 24, 1912. On the lactation following the birth of the second calf she made a record of 12,426.4 lbs of milk and 450.75 lbs. of fat, and was admitted as No. 426 to the Ayrshire Advanced Registry.

After March 24, 1913, the cow never gave any milk. The udder rapidly shrunk to a very small size and the animal began to show the external characteristics of a bull. This change was very slight at first, but soon became much more marked. *After a lapse of 8 months the general external facies and the behavior of the cow were like those of a bull to a remarkable degree.* The neck had become thickened in its posterior parts, and had developed a well-marked crest, as is characteristic of a bull. If the cow had been so screened that only her fore-quarters and neck were visible, any observer would have unquestionably pronounced her a male. The assumption of male characters in these regions was complete and perfect. In the hind-quarters the change from characteristic female conformation in the male direction, while less striking than in the anterior parts, was still clearly evident. The udder shrunk away to a very small size. The hips and rump took on the smooth, rounded, filled-out appearance which is characteristic of the bull, but not of the cow.

The cow was slaughtered on February 18, 1914. Autopsy showed as the only gross ab-

[1] This is a preliminary abstract of a paper having the title "Sex Studies. VII. On the Assumption of Male Secondary Characters by a Cow Affected with Cystic Degeneration of the Ovaries," shortly to be published in the Annual Report of the Maine Agr. Expt. Sta. for 1915.

normality a simple cystic condition of the ovaries. Histologically and cytologically these cystic ovaries differed from the normal cow's ovary in but one essential respect, namely, that they had no corpora lutea.

The case described presents for consideration certain definite and clear-cut results bearing on the problem of secondary sex characters. These are:

1. This cow had been a perfectly normal female and had performed all the reproductive functions, both primary and secondary, of the sex.

2. It later assumed certain of the secondary characters of the male, both in respect of structure and behavior, with perfect definiteness, and, so far as the characters concerned go, completeness. This change was, for example, at least as complete and definite as any of those described by Steinach[2] following castration and transplantation of gonads.

3. The gonads of this animal, examined subsequent to the change in secondary characters, were exactly like those of a normal cow, save in the one respect that the follicles were not breaking and discharging ova, but were forming follicular cysts or becoming atretic, and because of this no corpora lutea were formed.

(*a*) The interstitial secreting mechanism of these ovaries was absolutely normal, both in respect of number of cells, and the cytological characteristics of the individual cells.

(*b*) The germinal mechanism was perfectly normal up to the point where ovulation should occur. Then it failed to separate the ova from the ovary.

(*c*) The outstanding, and so far as we can determine the only significant, anatomical and physiological difference between the gonads of this abnormal cow and those of a normal one, consists in the fact that the former lacked any lutear tissue.

A detailed account of the case, with figures, will be given in the complete paper.

RAYMOND PEARL,
FRANK M. SURFACE

[2] Steinach, E., "Willkürlich Umwandlung von Saügetiermännchen in Tiere mit ausgeprägt weiblichen Geschlechtscharacteren und weiblicher Psyche," *Pflüger's Arch.*, Bd. 144, pp. 71–108, 1912.

A NEW THEORY REGARDING THE FEEDING POWER OF PLANTS[1]

THE feeding power of plants has been a subject of a great deal of investigation during the last half century. Undoubtedly mere casual observation of the growth of wild and cultivated plants led investigators long ago to surmise that there is a difference in the feeding power of different species of plants. Numerous carefully controlled experiments have repeatedly confirmed this idea. Of the important mineral elements needed by plants, sufficient phosphates in an available form are most often lacking in a soil. It is largely on this account that phosphates have generally been used in testing the feeding power of plants. Fortunately phosphates are also well adapted to this study. With the rapidly increasing use of phosphate fertilizers, the subject has become one of considerable economic importance, since it may be possible that with a proper selection and sequence of crops as regards their feeding power, the cheap insoluble phosphate fertilizers may be used with greater advantage.

It was formerly supposed that insoluble minerals were made soluble by plants through the action of various acids secreted by the plant roots. As is well known, later experiments, especially those by Czapex, have demonstrated that other than carbonic acid, plants normally excrete at the most, only minute traces of acids. There remains, however, no question that practically all plants excrete through their roots large quantities of carbonic acid. Lately some investigators have suggested that differences in feeding power may be due to differences in amount of carbonic acid excreted by the roots. Experimental data, however, lend little support to this view, and hence indicate that there must be something vastly more important in determining the feeding power of a plant. On reviewing the literature concerning the subject, and considering the data obtained in this laboratory, the writer was led to formulate the following hypothesis:

Plants containing a relatively high calcium

[1] Publication authorized by the director of the Wisconsin Experiment Station.

oxide content have a relatively high feeding power for the phosphorus in raw rock phosphate. For plants containing a relatively low calcium oxide content the converse of the above is true. A calcium oxide content of less than one per cent. may be considered relatively low. Corn, oats, rye, wheat and millet belong in this class. A calcium oxide content of somewhat more than one per cent. may be considered relatively high. Peas, clover, alfalfa, buckwheat and most of the species of the cruciferæ belong in this class.

The explanation of the above relation is made possible by means of the laws of mass action and chemical equilibrium. The reaction making the phosphorus in raw rock phosphate available to plants is one between carbonic acid and the tricalcium phosphate in the rock phosphate, which may be represented as follows:

$$Ca_3(PO_4)_2 + 2H_2CO_3 \leftrightarrows Ca_2H_2(PO_4)_2 + CaH_2(CO_3)_2.$$

As is well known if none of the products to the right of the reaction are removed from solution, the reaction soon reaches a state of equilibrium. If the di-calcium phosphate is continually removed but the calcium bi-carbonate only in part, then the reaction will continue a little farther, but also soon comes to a state of equilibrium due to the accumulation of the calcium bi-carbonate. When this point is reached, the further solution of the phosphate is prevented. This is the condition that obtains for such plants as are low in calcium oxide and hence do not absorb the calcium bicarbonate in the proportion to the dicalcium phosphate as given in the reaction. In such cases, the plants soon suffer for soluble phosphates. If both of the products to the right of the reaction are simultaneously and continually removed in the proportion given, then the reaction continues from left to right and there results a continuous supply of soluble phosphates along with soluble calcium bicarbonate. This is the condition that obtains, at least in part, with plants containing a high calcium oxide content, and hence such plants are strong feeders on raw rock phosphate.

In accord with other investigators the writer has found that the use of ammonium nitrate or sulfate as a source of nitrogen in quartz plant culture work, greatly increases the availability of raw rock phosphate to plants which are normally weak feeders on this material. In the light of the present theory this is very satisfactorily explained as follows: Calcium bicarbonate being much more soluble in a water solution of ammonium salts than in water alone, it follows that the addition of ammonium salts allows the preceding reaction to continue from left to right to a much greater extent than if water alone is present. The addition of a salt in which the products of the reaction are more soluble has the same effect to a certain extent as is obtained by removing the products of the reaction.

With the theory[2] here proposed it is possible to predict from the calcium oxide content of a plant whether or not that plant in quartz cultures will be a strong or weak feeder on raw rock phosphate. Under soil conditions there are many subsidiary factors that influence the availability of phosphates, and hence under such conditions the relative growth of a plant can not be taken rigidly as a true index of its feeding power for the limiting element which is supplied in an insoluble form. Seeming deviations from the theory may result under such conditions. It is possible that with proper restrictions the theory can be applied to the feeding power of plants in a broader way, involving the use of other insoluble plant-food materials besides rock phosphate, and the general theorem could then be worded as follows: The feeding power of a plant for an insoluble substance depends primarily upon two conditions, viz., (1) the solubility of that substance in carbonated water and, (2) whether or not the plant removes from solution all the products of the solubility reaction in the proper proportion, so as to allow the solubility reaction to continue indefinitely.

With the theory here presented the writer

[2] Since writing this article the writer's attention has been called to a recent publication in *Zhur. Opytn. Agron.*, 15 (1914), No. 1, 54, by F. V. Chirikov, who from entirely independent work from this, has come to practically the same conclusion as the one set forth in this paper.

believes that the feeding power of plants is satisfactorily explained, without the intervention of other acids than carbonic. Since the failure to establish that plants excrete notable amounts of other acids than carbonic, some investigators, as previously stated, have suggested that the differences in feeding power may be due to differences in amount of carbon dioxide excreted. A careful consideration of available data lends little support to this idea. It seems rather that it is the efficiency with which the carbon dioxide is used, and not the differences in amount excreted by different species of plants, that determines whether or not a plant will feed strongly on an insoluble material.

The writer has in preparation a detailed article dealing with the feeding power of plants and the availability of phosphates.

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THE SOCIETY OF AMERICAN BACTERIOLOGISTS[1]

SYSTEMATIC BACTERIOLOGY

Under the supervision of H. A. Harding

A Study of B. subtilis by Means of the Classification Card: H. Joel Conn.

One hundred and thirty cultures of the *B. subtilis* type, isolated from soil, have been studied by means of the classification card adopted by the society. The definition adopted for *B. subtilis* is: a large, peritrichic, spore-producing rod, facultative anærobic in the presence of dextrose, liquefying gelatine, and growing vigorously on ordinary media without chromogenesis, producing a membraneous more or less wrinkled growth on the surface of agar. Two questions have been considered: (1) Do the determinations called for on the card separate these 130 cultures into more than one species? (2) Does the same culture always give identical results upon repetition of the tests?

In answering the first question half of the determinations represented by the "Group Number" on the card were excluded because they are implied by the definition of *B. subtilis.* The determinations taken into account were the fermentation of sugars and glycerin, and the reduction of nitrates. The nitrate reduction determination gives quite clear-cut results and may serve to separate an infrequent nitrate-negative species from an abundant nitrate-positive species. The fermentation tests do not give such definite results. They suggest that the 130 strains do not differ from each other in fermentative powers, but give inconstant results with the present technique.

The second question was answered in the negative as regards the fermentation tests; the nitrate reduction test seemed more constant, but insufficient data is at hand to settle the matter.

These tests indicate that with our present technique different "group numbers" do not always indicate different species. One of the first steps needed in revising the card is to establish the best methods for making the various determinations.

Some Induced Changes in Streptococci: Jean Broadhurst.

Various relatively simple physical and chemical factors (such as changes in temperature and differences in artificial media) differ greatly from such agents as saliva, intestinal extracts, and pure cultures of other bacteria, in their effects upon the physiological activities of selected strains of streptococci. The physiological effects of the former, especially in the various test media containing the sugars and the related substances suggested by Gordon, are mainly of a negative or inhibiting type, and apparently temporary only.

The changes induced by the latter factors (saliva, intestinal extracts, etc.) are, however, markedly different. They are changes in kind not in amount of reaction; they are active and usually include new powers, not merely the inhibition or occasional stimulation of earlier powers or capabilities, and often indicate a complete rearrangement of the fermentative complex. These induced changes have, so far, been practically permanent.

A Study of the Correlation of the Agglutination and the Fermentation Reactions among the Streptococci: I. J. Kligler.

Bacteria have evolved so little along gross structural lines that it is impossible to differentiate members of the same genus on a merely physical basis. We therefore resort to the more delicate criteria of protoplasmic constitution and physiological activity, in which direction remarkable differentiation exists. Tests for the finer structural differences of these organisms are found in their behavior to differential stains, such as the Gram stain, and to the immune substances in-

[1] Abstracts of papers presented at the Philadelphia meeting, December 29, 1914.

duced by them in the animal body. Their physiological activity is measured by the end products of their metabolism. Physiologically, bacteria, generally, have evolved in two main directions—one group possessing marked carbohydrate splitting properties, the other having developed the property of digesting various protein substances. The streptococci belong to the former division, showing but little tendency to proteolysis.

It appears natural enough to assume that the biologic activities of a cell would correspond with the chemical nature of its protoplasm. Yet such a correlation has not been worked out except in a few isolated cases. Among the streptococci such a correlation, if it exists, would be especially significant in that it would help to differentiate the various members of a genus that has puzzled many investigators.

The agglutination, fermentation and hemolytic properties of sixty strains of streptococci obtained from various pathological conditions, were studied, using four agglutinating sera having a titer of 800–1,000, and six carbohydrates and other fermentable substances as follows:

Disaccharides	Lactose
	Saccharose
Trisaccharide	Raffinose
Alcohol	Mannite
Glucoside	Salicin
Starch	Inulin

Only a limited number of the strains were agglutinated by the sera used. A definite correlation was, however, obtained between the agglutinative and fermentative characters. The serum produced by a strain of one fermentative group (the group that fermented salicin, for instance) agglutinated only cultures of its particular division and failed to agglutinate members of any of the other groups. No such correlation was obtained with the hemolytic property, members of one hemolytic group being agglutinated by the sera produced by strains from other hemolytic groups.

The results obtained indicate that a separation of the streptococci obtained from various pathological conditions into three fermentative types would coincide most closely with their natural relationship.

The groups suggested are:

1. Salicin fermenters only, generally hemolytic —*Str. pyogenes.*

2. Raffinose fermenters, salicin usually fermented, mannite always negative, generally produces a green colony on blood agar—*Str. salivarius.*

3. Mannite fermenters, generally ferment salicin, rarely ferment raffinose, variable in their reaction to blood—*Str. fecalis.*

The Filterability of B. bronchisepticus: with an Argument for a Uniform Method of Filtration: N. S. Ferry.

The purpose of the paper was to place on record a series of filtration experiments with *Bacillus bronchisepticus,* described as the cause of canine distemper by Ferry in 1910, McGowan in 1911 and Torry in 1913.

The experiments were conducted as follows: The organism was grown twenty-four hours both on agar and in bouillon. The bouillon growth was filtered, undiluted, while the agar growth was taken off in bouillon and made into a suspension of about the same density as the bouillon culture. The method of testing the integrity of the filters was that described by Bulloch and Craw in the *Journal of Hygiene* in 1909, which depends upon the measure of the pressure of air as it is allowed to pass through the pores of the candles while immersed in water. The filtration was conducted at room temperature, one hour taken as the length of time for filtration, and three pressures were used; gravity, 15 lbs. (negative) and 225 lbs. (positive).

The experiments proved conclusively that the *Bacillus bronchisepticus* is a filterable microorganism. The work also corroborates the results of previous investigators with regard to the fact that the less pressure used the more easily will some organisms pass through the filters.

Some interesting possibilities were suggested by the outcome of this work. Since 1905, when Carre claimed he had produced typical symptoms of distemper in susceptible dogs from the filtered discharges of diseased dogs, the majority of writers have classified the etiology of canine distemper as a filterable, invisible or ultramicroscopic virus, and it is so described in many textbooks. The work of Ferry, McGowan and Torry with the *Bacillus bronchisepticus* tends to refute the statements of Carre.

The results of the present filtration experiments puts an entirely new light on the subject. If the *Bacillus bronchisepticus* is the cause of canine distemper, then the experiments corroborate the work of Carre. If the work of Carre was correct, and if the causative agent of canine distemper is a filterable virus, then the experiments point very conclusively to *Bacillus bronchisepticus* as the etiological factor and confirms the findings of the three previously mentioned investigators.

The author suggests that steps be undertaken for making out some uniform method of conducting filtration experiments of testing the efficiency of the candle and expressing or recording the results.

Influence of the Concentration of the Nutrient Substrate upon Microorganisms: Zae Northrup.

1. *Determination of the Influence of the Concentration of the Gelatin in Nutrient Gelatin, upon Liquefying and Non-liquefying Organisms.*—Gelatin media, having the same amount of other nutrient substances than gelatin, per unit volume were prepared, using 15 per cent., 25 per cent., 35 per cent., 50 per cent. and 75 per cent. gelatin.

Difficulties were met in the preparation of the highest percentage of gelatin on account of the thick sticky nature of the mass, but an excess of water was added to make the mixture homogeneous, this water being then driven off by evaporation on a water bath.

Pure cultures of both liquefying and non-liquefying organisms were plated on the different concentrations of gelatin.

On account of the extreme viscidity of the 75 per cent. gelatin it could not be plated in the usual manner; a thin film of the gelatin was spread over a sterile glass slide in a sterile petri dish and inoculated by spreading a small drop of a 24-hour culture of the organism on the surface of the gelatin.

The number, size and appearance of colonies were to be noted on the media of the respective concentrations.

In counting, the low power of the compound microscope ocular No. 1 and objective No. 7 was found to give counts 3–4 times as high as the ordinary counting lens.

The numbers of organisms developing on the plates are influenced to some but not to any marked extent, if the mechanical difficulties of inoculating the gelatin and pouring the plates are taken into consideration. The decrease or variations noted may be due only to experimental error.

The size of the colonies was found to be inversely proportional to the concentration of the gelatin. This was especially marked in the case of the organisms which are the most active in liquefying gelatin.

The type and appearance of the colonies were also found to be worthy of note. The subsurface colonies of both liquefying and nonliquefying organisms appeared like very fine gas bubbles distributed throughout the medium. The active liquefying organisms began to show a rectangular instead of a concave depression in surface colonies on 35 per cent. and 50 per cent. gelatin, while with the slow liquefier a new type of growth, a stalagmite-like or apiculate growth, appeared on the 50 per cent. gelatin. This type of growth was noted in the 25 per cent. gelatin of colonies of the non-liquefying organisms.

B. typhosus was the only organism among the eight types used in the experiment which refused to grow on the 50 per cent. gelatin. However another trial might prove successful.

The different phenomena observed in the course of this experiment will most probably call upon the sciences of physics and of physical chemistry for their interpretation.

Several questions have been called forth by the results of this experiment and most of them remain as yet unanswered.

What part does the medium or substratum and what part does the organism play in the formation of the so-called characteristic growths which are obtained in solid media? What force or forces cause the variation in types of liquefaction produced by various proteolytic enzyme-forming organisms? Does the inherent nature of the organism or its secretions play the greater part or are physical or physico-chemical forces the greater factor?

Why is the size and the structure of the colony so markedly influenced by the media of increasing concentration? It is not due to osmotic pressure, as gelatin is a colloid and consequently will exert no osmotic pressure.

Is it due to the lack of water or is it due to some physical property of the gelatin, as surface tension, which is more evident in greater concentrations?

What force causes the colony in a nutrient gelatin of high concentration to show a rectangular depression when in ordinary nutrient gelatin the depression is concave?

In the liquefaction of ordinary nutrient gelatin what part does the force of gravity play?

An interesting occurrence was noted in the "plates" made with the 75 per cent. gelatin. Upon examining these plates, several days (exact period of time not noted) after they were made, the glass slides were found in very fine pieces as if crushed by a powerful force. This occurred in every case. The crushing of the slide was evidently due to the contraction of the highly concentrated gelatin upon cooling and solidification. Just how much energy it will take to crush slides by mechanical force is yet to be determined.

The determination of the various physical and physico-chemical forces will serve to give some idea of the factors which microorganisms have to overcome in growing in gelatin and similar media of high concentration.

This experiment was worked out by Mr. O. M. Gruzit, a senior student.

Induced Variations in Chromogenesis: M. R. Smirnow.

Of the various biological characters of bacteria, one of the most interesting yet least important is that of pigment production. Though considerable efforts have been expended in the study of this function, little of real value is as yet available. It appears that this property is especially prominent amongst the saprophitic organisms, and depends to a greater or less extent, on certain conditions of environment which vary with different bacteria, and is, as a rule, more or less constant for the same organisms.

With the exception of *Spirillum rubrum* and possibly a few others, the chromogenic bacteria require an abundance of free oxygen, giving no pigment under anærobic conditions of growth. Temperature also seems to determine pigment production of some bacteria, thus the *B. prodigiosus* will give no pigment at 37° C.

Perhaps the most important influencing agent on the function of chromogenesis is the medium on which the organism is grown. With other factors of environment constant, chromogenesis will vary with the medium employed. Gessard, for instance, has shown that the *B. pyocyaneus* will produce only a blue color, of a most beautiful shade, in a two-per-cent. solution of peptone, which may be increased in intensity by the addition of five-per-cent. of glycerin. When grown on egg-white or other albumen or on weak glucose media it would produce a fluorescent green. This same organism when grown on a five- or six-per-cent. glucose medium or on immune serum would give no pigment. He believes that phosphates are required for the production of the fluorescin.

Substances that enhance the value of culture media, in a general way increase also the pigment production. Other substances, as acids or alkalies, may diminish or even inhibit its production. Some organisms may give different colors on media of different reaction. Thus the *B. prodigiosus* gives a distinct yellow color on alkaline, and a violet-red on acid media.

In what manner the pigment is produced is not yet known. It is regarded that the property of pigment production keeps pace with other biological characters, as enzyme formation. This, the writer does not feel to be correct, inasmuch, as will later be shown, he has succeeded in increasing the chromogenic properties of some bacteria with a coincident decrease of enzyme formation. Some of the higher forms of organisms give rise to pigment as a function closely related with their nutrition and may possibly be regarded as products of metabolism. In these cases the pigment is obtained from the medium and is stored up in the bodies of the cells, as in the case of sulphur bacteria. Or, it may be produced on certain media containing iron, as evidenced in the so-called iron bacteria, through the products of metabolism and the production of sulphide or iron.

Chromogenesis may be increased not only by growing the bacteria on more favorable media and environment, but also by the process of selection, transplanting each time from portions of the culture or from a colony that shows the most pronounced pigment.

Experimentally induced variations in the chromogenic properties of the *Staphylococcus pyogenes aureus* may be brought about by exposure to phenol or by growth in phenol, glucose, sodium sulphate or sodium chloride broth. Nine different strains of the *Staphylococcus* were used in the work here reported. Five of these were old stock cultures giving little or no color; the remainder were a few months old and showed a fair amount of pigment at the beginning of the experiments.

The organisms were grown in the above media for from six to ten weeks, being transplanted every three or four days during the entire time. They were then grown on potato and blood serum media for from 24 to 120 hours, and the effect on chromogenesis noted.

The increase of chromogenesis is brought about more readily by growing the organisms in phenol broth than by exposing them to 75 per cent. phenol solution and transferring on to agar. Of the nine strains used phenol markedly increased the chromogenic properties in six, Nos. 1, 2, 5, 6, 7, 8; slightly increased it in Nos. 4 and 9 and left No. 3 practically unchanged or even slightly diminished. Growth in dextrose, sodium chloride and sodium sulphate broth invariably decreased or left unchanged the quantity of pigment produced. Often almost a pure white growth of the various cocci, subjected to the growth in NaCl and Na_2SO_4 broth, would be seen when transferred to potato or blood serum.

An old stock culture of the *B. prodigiosus* was also used. This organism gave the slightest trace

of color at 20° C. at the beginning of the experiment. The organism was subjected to phenol only, beginning with a few minutes' exposure to a 0.75 per cent. solution and increasing as it became more resistant up to fifty or sixty minutes. Cultures were made on agar and grown at 20° C.

A striking increase in color production on all media resulted, the color becoming deeper and deeper until the maximum was reached at the thirteenth exposure. Up to the nineteenth exposure the color of each succeeding growth became most pronounced in 48 hours. From thereon, with increasing time exposures, the color production was slower, the color reaching its maximum in three or four days. Different shades of red were produced on different media. On agar, the color was deep brick red; on blood serum it had more of a scarlet hue; while on potato the color was somewhat variable and not as marked as on the other media. It was, however, on glycerin agar and glycerin potato that the most striking results were observed. The original strain gave no color on glycerin agar, and only a pale, delicate reddish color on glycerin potato. Transplants made from the phenol exposed organisms gave a brilliant cherry-red color on glycerin potato spreading to surround the entire surface of the medium. On glycerin agar, a dull cherry-red color was obtained.

In summing up what has been said concerning chromogenesis, it becomes evident that this faculty is more or less closely associated with the metabolic activities of bacteria, nutritive or otherwise. It varies with the strain and is more or less dependent on oxygen, temperature, and the medium used. An organism may produce more than one color at once and the same time or it may produce different colors, depending upon environment and the medium used, particularly the latter. Finally, chromogenesis may be varied through the agency of chemicals, as seen by the work here outlined, phenol generally increasing, and glucose, sodium chloride and sodium sulphate diminishing this function.

Induced Variations in the Cultural Characters of B. coli: M. R. Smirnow.

The same technique that was used in the experiments on chromogenesis was made use of here. In all, 21 different strains of the various bacilli of the colon-typhoid group were used, but this report is confined only to the *B. coli*, of which seven different strains were experimented on. All of these strains were obtained from the Museum of Natural History of New York through the kindness of Dr. C.-E. A. Winslow, and were the stock Nos. 19, 44, 45, 46, 52, 57 and 95. The transplanting was carried out every three or four days over periods varying from one to three months, thus allowing from ten to thirty or more transfers. The results obtained in each set of experiments were rather constant, though not altogether so, inasmuch as some of the strains reacted quicker or different in the degree of the action at one time than another.

Control cultures were carried on in plain broth throughout the experiment. It might be stated at once that there were very slight variations between the original stocks and these control cultures, but no more than would be expected as normal variations. These were seen as slightly increased or decreased amounts of gas or acid formation, in time of coagulation, or slight changes in the growth on potato. At no time, however, were the biological characters markedly changed nor enzyme production completely inhibited simply by continual passage through broth.

Growth on Potato.—Dextrose seemed to have a special effect upon the character of growth of *B. coli* on this medium. Five of the seven strains showed at best only a slight yellow or a very light brownish growth on ordinary potato, with practically no discoloration of the medium. Very frequently, indeed, the dextrose-affected organisms would give the typical "invisible" growth seen with the *B. typhosus*. Both the original stock and the control showed the characteristic colon growth on this medium. This change was noted so many times that the explanation based on differences in the composition of the potato could be excluded. Three of these five strains also showed this change after exposure to phenol. One strain of the *B. coli*, not changed in this respect with either dextrose or phenol, showed this same variation after growing in either sodium chloride or sodium sulphate broth.

Action in Milk.—Both phenol and dextrose diminished the acid production and inhibited the formation of lab enzyme in three of the seven strains of the *B. coli*, either entirely or for a period of two weeks at least. These results were not seen with the use of the strong saline or sodium sulphate broth.

Fermentation of Sugars.—The results obtained with these substances on *B. coli* with reference to variations in sugar fermentations can be best seen in the accompanying charts. The most striking changes here also were seen in those organisms

exposed to dextrose and phenol. The former completely inhibited both acid and gas formation and all the sugars tested in three different strains. In two other strains dextrose varied the fermentation of the sugars as to amount of acid and gas formation, some of which were totally inhibited. Phenol inhibited these fermentations in all of the sugars in only one case, and in four other strains it at times diminished this reaction to the point of inhibition. Sodium chloride and sodium sulphate had less effect than did phenol, giving usually slight variations in amount of acid or gas produced with an occasional inhibition.

Inhibition of all the sugar fermentations in any one experiment was almost always accompanied by inhibition in the usual changes in milk, the characteristic growth on potato, and the formation of indol.

Variations in Indol Production.—The production of indol is regarded by many bacteriologists to be as important a biological characteristic of *B. coli* as its fermentations of the sugars, and is even thought to be of greater importance in its differentiation. This quality, however, under normal conditions, varies considerably in its quantity and time of appearance with most strains, and at times requires more delicate tests than the usual Salakowsky method for its determination.

In the experiments here reported it appears that of the variations induced in *B. coli* that of indol production is the first to take place, often disappearing in the third or fourth culture in dextrose broth. This does not hold however when the bacteria grow in the other media, as evidenced below.

Each strain of *B. coli* was grown in plain broth as control, in dextrose, phenol, sodium chloride and sodium sulphate broth and on potato. Thirty-five sub-cultures were made in all. Indol was tested for after the 10th, 15th, 25th and 35th transfers. The tests for indol were made by inoculating one loop of culture from the respective media to which each strain was subjected into standard peptone solutions, grown for seven days at 37° C. and then tested by the Salakowsky method. All the tests were done at the same time, using the same batch of peptone solution throughout the experiment.

All the controls, grown in plain broth gave good indol tests even after the 35th sub-culture. Those grown in dextrose broth gave none at the 10th subculture nor thereafter. In phenol broth the property of indol production seemed to be somewhat increased, judging from the intensity of the reaction. Sodium chloride and sodium sulphate and prolonged cultivation on potato practically exerted no influence, or if any, showed but a slight inhibitory effect.

Experiments were then carried out to see how soon the property of indol production is interfered with by growth in three per cent. dextrose broth, and it was found that *B. coli* lost this property usually on the third and at times on the second transfer over a period of from seven to ten days. In one experiment sub-cultures were made every 24 hours, with a total disappearance of the indol tests in 48 or 72 hours in all the strains.

In order to exclude the possibility of interference in the indol test by the presence of three per cent. dextrose, several cultures in plain broth, also peptone, were made and grown at 37° for seven days. Dextrose was added to each of the cultures and then tested for indol. Positive tests were obtained in all, hence excluding any possibility of such interference by the presence of the carbohydrate.

Experiments were then carried out to determine the permanency of this change. The cultures in dextrose broth after the 35th transfer were taken and grown in plain broth, transplanting every day and tested on the seventh day of incubation. Four of the strains of *B. coli*, Nos. 44, 45, 46 and 52, gave slight indol reactions on the third transfer, No. 46 gave a good positive on the fifth transfer, but the others took five to ten more transfers before they could be called "+" or "++" positive. Nos. 57 and 95 took six transfers before a trace of indol appeared. No. 19, a very feeble indol producer in the control, remained negative up to the fifteenth transfer, at which time the experiment was discontinued.

In summing up then, it can be said that dextrose and phenol, particularly the former, cause partial inhibition or total disappearance of acid and enzyme formation in some strains of *B. coli*. These changes, together with the suspension of the production of indol and the characteristic colon growth on potato, make the *B. coli* approach if not entirely appear like the *B. typhosus* type organism. These changes have been noted time and again, but in varying degrees, in those strains that are susceptible to variations, but for some unexplained reason can not be regarded as altogether constant. Indol formation would invariably return when these altered bacteria were transplanted into plain broth at frequent intervals. Lab enzyme would also return in most of the altered strains, but not invariably so. The same can be said of the fermentative properties, but even to a less extent. Very often, however, these characteristics appear to be entirely done away with, the change

being permanent as far as could be made evident by sub-culturing into plain broth. In these cases observations were made up to two months after the last exposure to the influencing substance, making frequent transfers. There seemed to be no definite rule of reversion, no constant results and no relation between the reappearance of one enzyme and another. The reappearance of the fermenting enzymes in one sugar was not necessarily accompanied by those in other sugars. At times the fermentation of one sugar might have returned to nearly normal, while others might show little or no presence of gas with the same strain of *B. coli*.

Halophytic and Lime Precipitating Bacteria: K. F. KELLERMAN AND N. R. SMITH.

Of approximately 70 cultures isolated from the Great Salt Lake and from sea water from Florida and the Bahamas three types of organisms were secured. *Pseudomonas calcis*,[2] a new spirillum and a new bacterium were isolated from the sea water. Closely similar varieties of species of *Spirillum* and *Pseudomonas* were found in water from the Great Salt Lake. Both in sea water and in the Great Salt Lake these bacteria are associated with the precipitation of calcium carbonate.

Relation of Crop to Bacterial Transformation of Nitrogen in the Soil: K. F. KELLERMAN AND R. C. WRIGHT.

Progress report upon continuation of work reported[3] previously.

The Influence of Hydrogen-ion Concentrations upon the Physiological Activities of Bacillus coli: WM. MANSFIELD CLARK.

Attention is called to the importance of hydrogen-ion concentration for the physiology of cells and to to its importance for the solution of various problems of bacteriological chemistry. The experiments of Michaelis and Marcora upon the limiting hydrogen-ion concentration for *B. coli* have been elaborated and it is shown that although minor differences exist there is a limiting concentration at or above which all activity ceases. The same results were obtained with various cultures of the true colon bacillus. At the limiting hydrogen-ion concentration proteolysis is inhibited. With increase in temperature the effect of hydrogen-ion concentration increases. The relation of this fact to the so-called thermal death point is pointed out.

An example is given showing the usefulness of the hydrogen-electrode in bacteriological research. By a study of the reaction of the medium at the close of the fermentation it was shown that by the use of *p*-nitro phenol a separation of the colon arogenes family could be accomplished. The groups so separated were rigidly correlated with the gas ratio.

Bacteria of the Colon Type Occurring on Grains: L. A. ROGERS, WILLIAM MANSFIELD CLARK AND ALICE C. EVANS.

In an earlier paper it was shown that the colon bacteria of bovine feces belong to a very sharply defined type which was characterized by the production of a relatively small amount of gas composed of hydrogen and carbon dioxide in almost exactly equal parts. A study of the gas production by 166 colon-like cultures from grains as determined under carefully controlled conditions showed that these cultures could be divided into three physiological groups. These were (1) cultures giving a low volume composed of carbon dioxide only; (2) those giving a low volume and a carbon dioxide-hydrogen ratio of 1.06 and (3) those giving a high volume and a ratio varying from 1.90 to 2.90. The cultures producing a carbon dioxide only were also distinguished by the rapid liquefaction of gelatin. The low-ratio cultures, although agreeing with the fecal type in the gas production, were distinguished by the production of a yellow pigment. The 151 high-ratio cultures were divided into four types. Ninety of the 151 liquefied gelatin slowly, gave a carbon dioxide-hydrogen ratio of 2.50 to 2.80, produced a light cadmium pigment, failed to form indol from tryptophane, fermented saccharose and glycerine, and failed to ferment starch, inulin and adonite. Forty cultures failed to liquefy gelatin, gave a gas ratio of 2.20 to 2.50, and produced a light cream-colored pigment, did not produce indol from tryptophane, fermented saccharose, lactose and raffinose, but almost always failed to ferment the other test substances.

Two other groups, differing in their gas ratio and fermentation reaction were made but they included a relatively small number of cultures.

A. PARKER HITCHENS,
Secretary

(*To be continued*)

[2] Kellerman, Karl F., and Smith, N. R., "Bacterial Precipitation of Calcium Carbonate," *Jour. Washington Academy of Sciences*, Vol. IV., No. 14, August 19, 1914, pp. 400–02.

[3] Kellerman, K. F., and Wright, R. Claude, "Mutual Influence of Certain Crops in Relation to Nitrogen," *Journal American Society of Agronomy*, Vol. 6, 1914, pp. 204–10.

SCIENCE

FRIDAY, MAY 7, 1915

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE CONTRIBUTION OF THE CHEMIST TO THE INDUSTRIAL DEVELOPMENT OF THE UNITED STATES[1]

SINCE the outbreak of the European War, the American public has been led, adroitly or otherwise, to believe that industrial chemistry, that is, the industrial activity of the chemist, is limited to coal-tar dyes and that nothing should be regarded as industrial chemistry that does not deal with the manufacture of these dyes. Nothing could be further from the truth.

While it is true that the manufacture of coal-tar dyes forms an important branch of industrial chemistry, or of chemical industry, whichever you will, it by no means forms the whole of it or even a preponderating part of it.

From the economic point of view, economic effect and economic result is the measure to apply in determining economic importance and not the intellectual or scientific labor involved in the creation of that result.

From a strictly economic point of view coal-tar dyes can hardly be said to be vital or essential and by that I mean that we can get along without them and not suffer great hardship, personal or otherwise; anything of less need than that can hardly be called an economic necessity.

THE CHEMIST AND HIS WORK

The American public has seemingly given too little consideration to those industries of this country that make use of chemical knowledge and experience in the

[1] From the public address at the fiftieth meeting of the American Chemical Society, New Orleans, March 31 to April 3, 1915.

manufacture or utilization of products and yet these are the ones that compose chemical industry or industrial chemistry.

For the present, permit me to give in a few words the substance of the impressive series of papers presented at the meetings of this forenoon and this afternoon, and, as this presentation is being made, please have in mind the question as to whether you would prefer to have the United States able to produce all of its requirements of coal-tar dyes and *not* able to produce any of the various things which I am about to mention.

According to this symposium there are at least nineteen American industries in which the chemist has been of great help, either in founding the industry, in developing it, or in refining the methods of control or of manufacture, thus rendering profit more certain, costs less high and output uniform in standard amount and quality.

The substitution of accurate, dependable and non-failing methods of operation for "rule of thumb" and "helter-skelter" methods must appeal to every manufacturer as a decided advancement and a valuable contribution.

NINETEEN AMERICAN CHEMICAL INDUSTRIES

In presenting to you these various contributions of the chemist, I by no means wish to be understood as in any wise minimizing or reducing the contributions made to the final result by others, such as merchants, bankers, engineers, bacteriologists, electricians, power-men and the like; all that I wish to emphasize is that the chemist *did* make a contribution, and to that extent he is entitled to credit and acknowledgment.

The chemist has made the *wine industry* reasonably independent of climatic conditions; he has enabled it to produce substantially the same wine, year in and year out, and no matter what the weather; he has reduced the spoilage from 25 per cent. to 0.46 per cent. of the total; he has increased the shipping radius of the goods and has made preservatives unnecessary.

In the *copper industry* he has learned and has taught how to make operations so constant and so continuous that in the manufacture of blister copper valuations are less than $1.00 apart on every $10,000 worth of product and in refined copper the valuations of the product do not differ by more than $1.00 in every $50,000 worth of product. The quality of output is maintained constant within microscopic differences.

Without the chemist the *corn products industry* would never have arisen and in 1914 this industry consumed as much corn as was grown in that year by the nine states of Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey and Delaware combined; this amount is equal to the entire production of the state of North Carolina and about 80 per cent. of the production of each of the States of Georgia, Michigan and Wisconsin; the chemist has produced over 100 useful commercial products from corn, which, without him, would never have been produced.

In the *asphalt industry* the chemist has taught how to lay a road surface that will always be good, and he has learned and taught how to construct a suitable road surface for different conditions of service.

In the *cottonseed oil industry*, the chemist standardized methods of production, reduced losses, increased yields, made new use of wastes and by-products and has added somewhere between $10 and $12 to the value of each bale of cotton grown.

In the *cement industry*, the chemist has ascertained new ingredients, has utilized theretofore waste products for this pur-

pose, has reduced the waste heaps of many industries and made them his starting material; he has standardized methods of manufacture, introduced methods of chemical control and has insured constancy and permanency of quality and quantity of output.

In the *sugar industry*, the chemist has been active for so long a time that "the memory of man runneth not to the contrary." The sugar industry without the chemist is unthinkable.

The *Welsbach mantle* is distinctly a chemist's invention and its successful and economical manufacture depends largely upon chemical methods. It would be difficult to give a just estimate of the economic effect of this device upon illumination, so great and valuable is it.

In the *textile industry*, he has substituted uniform, rational, well thought-out and simple methods of treatment of all the various textile fabrics and fibers where mystery, empiricism, "rule of thumb" and their accompanying uncertainties reigned.

In the *fertilizer industry*, it was the chemist who learned and who taught how to make our immense beds of phosphate rock useful and serviceable to man in the enrichment of the soil; he has taught how to make waste products of other industries useful and available for fertilization and he has taught how to make the gas works contribute to the fertility of the soil.

In the *soda industry*, the chemist can successfully claim that he founded it, developed it, and brought it to its present state of perfection and utility, but not without the help of other technical men; the fundamental ideas were and are chemical.

In the *leather industry*, the chemist has given us all of the modern methods of mineral tanning and without them the modern leather industry is unthinkable. In the case of vegetable-tanned leather he has also stepped in, standardized the quality of incoming material and of outgoing product.

In the *flour industry* the chemist has learned and taught how to select the proper grain for specific purposes, to standardize the product and how to make flour available for certain specific culinary and food purposes.

In the *brewing industry*, the chemist has standardized the methods of determining the quality of incoming material and of outgoing products, and has assisted in the development of a product of a quality far beyond that obtaining prior to his entry into that industry.

In the *preservation of foods*, the chemist made the fundamental discoveries; up to twenty years ago, however, he took little or no part in the commercial operations, but now is almost indispensable to commercial success.

In the *water supply of cities*, the chemist has put certainty in the place of uncertainty; he has learned and has shown how, by chemical methods of treatment and control, raw water of varying quality can be made to yield potable water of substantially uniform composition and quality.

The *celluloid industry*, and the *nitrocellulose industry*, owe their very existence and much of their development to the chemist.

In the *glass industry* the chemist has learned and taught how to prepare glasses suitable for the widest ranges of uses and to control the quality and quantity of the output.

In the *pulp and paper industry* the chemist made the fundamental observations, inventions and operations and to-day he is in control of all the operations of the plant itself; to the chemist also is due the cheap production of many of the materials enter-

ing into this industry as well as the increased and expanding market for the product itself.

THE STATISTICAL POSITION

For the census year of 1909 the wage-earners and the value of manufactured products and the value added by manufacture in twelve of these industries and in the manufacture of chemicals is given in Table I*a*.

this amounts to about 15 cents per person per year.

Now, which would you rather have, these thirteen industries with their $2,500,000,000 worth of manufactured product or the coal-tar dye industry with its $100,000,000 of product? The number of persons employed in these above thirteen industries is in excess of 500,000; the entire world's supply of coal-tar dyes is made by fewer than 40,000 people. Which would you rather have?

TABLE I*a*

	Wage-earners	Product Value	Value Added by Manufacture
Wine	1,911	$13,120,846	$6,495,313
Copper	15,628	378,805,974	45,274,336
Fertilizer	18,310	103,960,213	34,438,293
Textiles	44,046	83,556,432	48,295,131
Canned and preserved foods	59,968	157,101,201	55,278,142
Cotton-seed oil	17,071	147,867,894	28,034,419
Cement	26,775	63,205,455	33,861,664
Sugar	20,730	327,371,780	52,523,806
Brewing	54,579	374,730,096	278,134,460
Leather	62,202	327,874,187	79,595,254
Glass	68,911	92,095,203	59,975,704
Paper and wood pulp	75,978	267,656,964	102,214,623
Chemicals (strictly)	23,714	117,688,887	53,567,351
Totals	529,823	$2,455,035,132	$897,688,496

TABLE I*b*

Iron and steel	278,505	$1,377,151,817	$399,013,072
Petroleum refining	13,929	236,997,659	37,724,257
Lead smelting and refining	7,424	167,405,650	15,442,628
Illuminating and heating gas	37,215	166,814,371	114,386,257
Confectionery	44,638	134,795,913	53,645,140
Paint and varnish	14,240	124,889,422	45,873,867
Soap	12,999	111,357,777	39,178,359
Carpets and rugs	33,307	71,188,152	31,625,148
Explosives	6,274	40,139,061	17,328,113
Zinc smelting and refining	6,655	34,205,894	8,975,893
Turpentine and rosin	39,511	25,295,017	20,384,174
Oil cloth and linoleum	5,201	23,339,022	7,788,921
Chocolate and cocoa	2,826	22,390,222	8,867,162
Baking powder and yeast	2,155	20,774,588	11,436,603
Dyestuffs and extracts	2,397	15,954,574	6,270,923
Blacking, cleansing and polishing preparations	2,417	14,679,120	7,716,728
Wood distillation other than turpentine	2,721	9,736,998	3,861,147
Oleomargarine	606	8,147,629	1,650,997
Totals	513,020	$2,605,262,886	$829,052,389
Total for 31 chemical industries	1,042,843	$5,060,298,015	$1,726,740,885
Total for all industries	6,615,046	$20,672,051,870	$8,529,260,992

AMERICAN INDUSTRIES VS. COAL-TAR DYES

A most liberal estimate of the market value of the world's entire production of coal-tar dyes places it under $100,000,000; the entire consumption in the United States is less than $15,000,000, duty included, and

These thirteen industries employ 8 per cent. of all wage-earners in manufacturing enterprises in the United States, produce 12 per cent. of the total value of manufactured product and 10.5 per cent. of the total value added by manufacture. In

other words, the chemist engaged in these thirteen pursuits plays an important, if not indispensable part in the lives of 8 per cent. of our wage-earners and affects 12 per cent. of our manufacture-values and 10.5 per cent. of our values added by manufacture. But the total number of chemists makes up only about 0.01 per cent. of the population of the United States.

NO NATION CAN DO EVERYTHING ITSELF

Of course, it may be said that having made all these other things, there is no excuse why the American should not make coal-tar dyes in addition. Perhaps so; but nations, like individuals, can not each have or do everything. If each nation could do everything equally as well as every other nation, there would be no occasion whatever for international business. As this world is constituted, each nation does that which it can do the best and trades off the product for what some other nation can do better than it, and both sides are satisfied and make a profit; this is the same as the relationship between individuals. The shoemaker can make shoes better than he can bake bread; he makes shoes and exchanges part of his income with the baker for bread which the baker has made.

If American chemists can operate these industries better than or as well as other nations, it is no real ground for criticism that they can not do everything better than any other nation, any more than the shoemaker is to be criticized because he can not make as good a suit of clothes as can the tailor. If you want the shoemaker to be able to make a suit of clothes as well as the tailor you must provide him with the opportunity to learn how to tailor and take care of him while he is learning, and no doubt his suit of clothes will cost him more than it would cost an established tailor to turn out the same kind of a suit of clothes, and you must again help your shoemaker while he is trying to market his suit of clothes against the established tailor.

EIGHTEEN ADDITIONAL AMERICAN CHEMICAL INDUSTRIES

The above nineteen American industries referred to by no means comprise all the American industries in which the chemist can be of help and of assistance. Many more are open.

A search through the census for 1909 discloses the eighteen additional industries listed in Table I*b* which make use of chemists in the control of their operations.

In these eighteen additional industries the chemist affects 8 per cent. of our wage-earners, 12.6 per cent. of our manufacture values and 9.7 per cent. of our values added by manufacture. For these thirty-one industries, then, the 0.01 per cent. of chemists of our population directly affect 16 per cent. of our wage-earners, 24.6 per cent. of our manufacture values and 20.2 per cent. of our values added by manufacture.

This, therefore, is a measure of the influence of the chemist upon the industrial development of the United States; however gratifying this result is, it is nevertheless true that many other industries could employ chemical control to great advantage, if they only would, and many establishments under the above cited industries could, if they would, make use of chemical control. There is plenty of work left for the chemist to do in these industries to keep him fully and profitably engaged. This being so, why should he not continue to direct his energies to improving those things that he already can do, rather than attempt new and exotic things which others can do better than he?

THE FOREIGN BUSINESS

So much for our internal relations. How about our international relations? To an-

swer this question I will use the official classification of the German government as to what constitutes products of and for chemical industry and also the same government's corresponding figures for 1913.

No two countries, speaking through their statistical departments, have the same working definition of chemical industry. None of the official classifications is as comprehensive as is the official German classification. So far as the exchange of products and commodities involved in chemical pursuits is concerned, the German classification shows a total of 442 items of which 229 are involved in international trade between Germany and the United States. According to these figures and this classification, the United States imported from Germany in 1913, $60,860,880, and exported to Germany $156,036,090, or a total business of $216,896,970, with a balance in favor of the United States of $95,175,210. I have selected from this 1913 list of items of business between Germany and this country those whose gross is $400,000 per annum or over (Table II).

It is interesting to note that we sell Germany more lard than Germany sells us of potash and aniline and other coal-tar dyes put together; that we sell Germany half again as much refined petroleum as it sells us aniline and other coal-tar dyes; that we sell Germany practically the same amount of pig and scrap lead as Germany sells us of alizarin and anthracene dyes; that we sell Germany almost as much paraffine as Germany sells us of indigo; and so on through the list.

RELATIVE QUALITIES OF IMPORTS AND EXPORTS

Of course, it will be contended that the things that we sell Germany are, from a chemical point of view, less refined, *i. e.*, involve less hard chemical intellectual work than do our imports from Germany. But, is most of the potash, which is practically mined from the ground in Germany, any more of a refined product than the phosphate rock we sell them? Does it not involve quite as much chemical ingenuity to produce good illuminating oil from petroleum as it does to produce many of the coal-tar dyes? There is no question that the general position above outlined is correct, namely, that our products, as a whole, are less refined than those that we get, as a whole, from Germany, but is that not true practically throughout our entire export and import business? Are not the textiles we export of a lower grade than those we import? Are not our leather products less refined than those we buy? And so on down the list. That being so, why pick out the chemist as a special mark for criticism when he is at least up to the average of his surroundings?

In 1913 the total foreign business of the United States amounted to $4,277,348,909, and the excess of exports of all kinds over imports of all kinds amounted to $691,-271,949.

The trade in chemicals and products of and for chemical industry between the United States and Germany in 1913 furnished 5 per cent. of that total of international business and provided 13.8 per cent. of the balance of trade.

THE INFLUENCE OF THE CHEMIST

The symposium of papers presented today constitutes a record of proud achievement, of solid accomplishment in nineteen different branches of American industrial activity, to which advance the application of chemical knowledge, chemical principles and chemical experience by American chemists, has contributed a noble share and an effective part. It is perhaps true that much of that progress would have come without the American chemist, but it is

TABLE II

U. S. Chemical Trade with Germany (1913)

U. S. Imports from Germany	Value in U. S. Money	U. S. Exports to Germany
	$75,000,000	1 Copper
	26,700,000	2 Lard
1 Potash salts	18,819,000	
	12,690,000	3 Refined petroleum
2 Aniline and other coal-tar dyes	7,290,000	
	4,970,000	4 Phosphate rock
	4,880,000	5 Oleomargarine
	4,585,000	6 Turpentine rosin
	4,460,000	7 Mineral lubricants
	3,840,000	8 Spirits turpentine
3 Caoutchouc	2,582,000	
	2,220,000	9 Crude benzine
	2,171,000	10 Beef tallow (prime)
	1,744,000	11 Nickel and nickel coin
4 Straw, esparto and other fibers; paper stock	1,649,000	
	1,550,000	12 Cotton-seed oil
5 Alizarin and anthracene dyes	1,463,000	
	1,421,000	13 Pig lead and scrap
6 Indigo	1,319,000	
	1,231,000	14 Crude and hard paraffin
	1,162,000	15 Acetate of lime
7 Platinum and allied metals	1,120,000	
8 Hops	952,000	
9 Miscellaneous volatile oils	941,000	
	903,000	16 Tin and tin scrap
10 Tin and tin scrap	900,000	
11 Potassium and sodium cyanide	845,000	
12 Chrome, tungsten, etc.	784,000	
13 Superphosphates	766,000	
	724,000	17 Crude wood alcohol
14 Beet sugar, refined	716,000	
	695,000	18 Carbides
	673,000	19 Miscellaneous volatile oils
15 Alkaloids exc. quinine	672,000	
16 Toilet and tooth powders	658,000	
	656,000	20 Heavy benzine and patent naphtha
17 Lime-nitrogen, etc.	635,000	
18 Potash carbonate	632,000	
	617,000	21 Lubricants of fats and o
	579,000	22 Beef and mutton tallow
19 Ferro-Al, Cr, Mn and Ni	567,000	
20 Potassium magnesium sulfate	509,000	
21 Gold ores	506,000	
	506,000	23 Copper alloys
22 Beet sugar, raw	492,000	
23 Aniline oil and salt	476,000	
24 Bronze and metal colors	473,000	
25 Glue	471,000	
26 Aluminum plates and metal	454,000	
27 Quinine and its salts	436,000	
	422,000	24 Portland cement
28 Terpineol and allied synthetics	409,000	
29 Gelatin	403,000	

equally true that under those conditions the advance would have been much slower and also much of what has been accomplished would never have happened at all without the faithful, enthusiastic and alert cooperation of the American chemists on the job. With such a record, the American chemist can hold up his head with pride and self-confidence, firm in the belief, and warranted in his conviction that he has done

a man's work, in a man's way, that he has not been an idler, nor a sloth, nor a drone, but that he has been one of the busiest of busy workers, with a keen eye and an alert intellect, always searching for an opportunity for the betterment of his industry, and for improvement of the conditions of his fellowman.

GERMAN SUPREMACY

That the chemist has not done more is by no means due to any unwillingness. It is due in the largest part to the apathetic attitude of those in charge of the management of many of our industrial enterprises requiring chemical knowledge in their exploitation. Many of these men in responsible positions do not have a chemical education even along the lines in which they are financially active. In those cases chemical novelties and chemical problems are not passed upon, on their merits, by chemists or by men with a chemical point of view, but by merchants, by lawyers and by bankers, men who, by their very training, are not capable of taking the chemist's point of view, of having the chemist's sense of proportion, and are unwilling to take a chemist's chance in a chemist's way. Therein lies, perhaps more than in any other one thing, the reason for Germany's supremacy in most of the branches of chemical industry. That also is the reason for the success of a great many of our own huge transportation, electrical and chemical enterprises. The business is run by men who know it from the technical point of view. Railroads are run by men who know the railroads from the operating and construction point of view; electrical enterprises by men who know the business from the electrical engineer's point of view, and they make their enterprises take their business chances in a transportation way, and in an electrical way. Practically all of our chemical enterprises that have been managed in the same manner have also been successful, but there is still great room for improvement, and just as soon as that improvement is accomplished, just so soon, and no sooner, will there be less and less talk about the incompetency of the American chemist. German chemical enterprises are run and managed by chemists.

Some years ago I was thrown in company with a very successful meat packer, and a very successful metallurgist; the packer asked me when chemists would make glycerin synthetically and make it cheap, as the price of glycerin was getting to be altogether too high; the metallurgist asked me, rather impatiently, what elements make up glycerin; somewhat dazed, I replied, "Carbon, hydrogen and oxygen." Thereupon the metallurgist said to the packer, "Why, carbon is coal, hydrogen and oxygen are water, both are plentiful and cheap; I do not see why these chemists can not mix coal and water and produce glycerin." I felt that my life was altogether too short to attempt to educate those two very successful men to a proper appreciation of the difficulties of converting coal and water into glycerin. This metallurgist's answer to the packer might with equal truth have referred to such dissimilar things as wood alcohol, grain alcohol, vinegar, olive oil, castor oil, whale oil, starch, camphor, cane sugar, beet sugar, grape sugar, carbolic acid, alizarin, and host upon host of similarly different things. I do not know whether that packer, when he got home, told his chemist to take a hunk of coal and drop it into a bucket of water, and make glycerin. I hope, for the chemist's sake, that he did not give him that task.

THE RESPONSIBILITY OF MANAGERS

If there is such a misconception of the chemistry underlying their own products

of manufacture on the part of many of our manufacturers, as this meat packer displayed, and if the general chemical viewpoint of the managers of many of our chemical industries is as confused and unfounded as was the view of this metallurgist, then it is no wonder that American chemical enterprises are behind some other countries; the real wonder is that we have any chemical industry at all. Nor is there any dearth in this country of properly trained chemists. There are almost ten thousand of them now in the United States, and they are being turned out by our technical and other schools with great regularity and with increasing volume every year. The fault is not with the American chemist, nor with his ability, nor his willingness; the fault lies principally and almost wholly with those in charge of many of our industrial enterprises, who fail absolutely in a chemical understanding of their own products and are devoid of any sympathetic contact with chemistry and with chemical points of view and therefore are incapable of, and unable to appreciate the value of chemical work or to have a wholesome understanding of the snares, the pit-falls and the tedium of chemical research.

CHEMISTS IN MANAGERIAL POSITIONS

This plea for the wider introduction of chemists in positions of managerial responsibility is, however, not to be interpreted into a statement that any kind of a chemist can do any kind of a chemical job. Just because a man can swing a scythe and cut wheat rapidly is no reason why he should be entrusted with the job of giving a man a shave; therefore, if you have a cotton oil problem, do not give it to a man whose specialty and training is in iron and steel only. The non-chemical managers of chemical enterprises will have their hands full picking out the right chemist for the right job and training promising chemical material for managerial positions. To do this successfully is quite an undertaking and will not be accomplished without many trials and many failures. Why should there not be failures? Not every man who is sent out on the road makes a successful traveling salesman, nor is every man put in as a superintendent a success as a superintendent.

In selecting your chemist for a responsible position, you must look out that you do not get a square peg for a round hole, just as you would when engaging a man for any other position, but the trouble seems to be with many of those who have engaged chemists, that they have not appreciated that there are chemists and chemists; they seem to have some sort of an idea that there is a magic about what a chemist does. Now, there is no magic at all. It is all plain, hard work, that calls for a lot of intellectual effort, and above all, the application of common sense, which, as every one knows, is a very rare article.

THE RESPONSIBILITY OF THE PUBLIC

With this record of solid achievement placed before you to-day, together with what I have just said, I hope that the conviction will finally break through, and will penetrate the public mind as well as the minds of those in charge of many of our industrial establishments, that if the American chemist is not doing as much as the public expect him to do, it is because the public through its industrial enterprises has deliberately declined to give him a chance. With this wonderful record of fruitful endeavor is the American chemist to have his chance? The answer to that question is largely in the hands of the American public.

However, the public will have to acquire in some dependable way an appreciation of what the chemists' work stands for and

really is. There are numerous difficulties in the way. By its very nature, the work of the chemist is more or less concealed from public inspection. If you have a particularly well tanned piece of leather, the layperson thinks no further than that it is a pretty good job, and is utterly unable to appreciate the large amount of work that has been necessary to produce or to create the way of making that particularly good piece of leather. There is nothing so conspicuous about the chemist's work as there is, for example, about the bridge builder's work, or about the work of a man who erects a skyscraper. The chemist's work, as a whole, does not fill the eye nor appeal to the imagination; and not filling the eye, and not appealing to the imagination there is really no practical method of valuation easily accessible to the ordinary individual; not only is the ordinary individual incapable of such a valuation, but even men high in industrial pursuits have not that particular intellectual vision which permits them to appreciate the real significance behind any given chemical product. The only exception hereto seems to be coal-tar dyes..

The reason for this exception is not hard to find. Could anything appeal more to the imagination than the conversion of such a disgusting, sickly mess as coal tar into brilliant colors that rival and excel every tint and shade in nature?

THE RESPONSIBILITY OF THE CHEMIST

However, the chemist must not attempt to absolve himself from all responsibility for the prevailing lack of appreciation or skepticism among capitalists and bankers of the value of chemical work in industrial operations. While competent chemists and chemical engineers by their very effective work have wrung from reluctant financial men proper acknowledgment of the value of chemical examination, control and management of enterprises requiring such, yet the work has not gone far enough, and it is not at all unusual for financial men to support with might and main enterprises which any qualified chemist or chemical engineer could and probably did tell them were foredoomed; also it must not be forgotten that qualified chemists and chemical engineers, like other professional advisers, have gone astray in their calculations and have supported enterprises which ultimately failed. The mining, electrical and railroad engineers finally succeeded in obtaining their present influential position among the industrial councils of this country and with the brilliant success of the chemical engineers of Germany in the same direction it is not too much to hope that ultimately the American chemist and chemical engineer will come into his own. When he does, there will be far fewer exploitations than heretofore of the wild and fantastic schemes of chemical enterprise now so easily financed by the gullible portion of our investing public and fewer and fewer failures of chemical enterprises undertaken in good faith and serious mood.

Therefore, let every chemist in advising on chemical operations prominently bear in mind that failure to give correct advice not only reacts upon him but upon each and every member of the chemical profession and merely helps to postpone the day when the chemist will come into his proper position among the makers of the nation.

CONCLUSION

To bring the matter up squarely before you let me recapitulate: The 10,000 chemists in the United States are engaged in pursuits which affect over 1,000,000 wage-earners, produce over $5,000,000,000 worth of manufactured products and add $1,725,000,000 of value by manufacture each year; the business in products of and for chem-

ical industry between the United States and Germany alone in 1913 provided 5 per cent. of our total foreign business and 13.8 per cent. of our balance of trade for that year. Please bear in mind that I am not by any means attempting to claim all the credit for this for the chemist; all that I ask is that his claims to recognition for intelligent, active and effective collaboration in bringing about those stupendous results be not thrown aside as worthless and that he shall not be made the target of unjust criticism because in 1914 there was a shortage of about $600,000 or 7 per cent. in coal-tar dyes and because cotton dropped from 15 cents to 6 cents.

Much more could be said of the chemist and his contribution to the effective every day labor of this work-a-day world but time and space forbid. I am sure that this short sketch of the chemist's activities, his hopes, his aims and his work will serve to create a wider interest in him and will result in according to him the credit to which he is entitled, namely, that he pulls more than his own weight in our nation's boat.

BERNHARD C. HESSE

THE GRAY HERBARIUM

THE rebuilding of the Gray Herbarium, which has been in progress for some years, has just been finished by the completion of the main central section of the building. The original structure, the gift of Nathaniel Thayer in 1864—at which date Dr. Asa Gray gave his invaluable botanical collections to Harvard University—was a brick building and for its time substantial, but the entire interior finish, including the floors, the plant cases, book shelving, etc., was of wood. The building had become wholly inadequate for the growing collections and was far from being fireproof in any modern sense.

The complete rebuilding and considerable enlargement was begun in 1909 and has been carried out a section at a time. It has been effected through the generosity of members of the visiting committee. The initial step consisted in the erection of a substantial ell, known as the Kidder wing, the gift of Mr. Nathaniel T. Kidder, of Harvard, '82. This wing, completed in 1910, provided convenient shelving space in exceptionally secure cases for more than 300,000 sheets of herbarium specimens as well as a portion of the library, thus giving great relief from the congestion of the older building.

In 1910 the adjacent residence, formerly occupied by Dr. Gray, was moved to the opposite side of Garden Street, and in its place was built in 1911 the Library wing of the herbarium. This portion of the building, furnishing ample quarters for the convenient shelving of the library, with extensive provision for its growth, was given anonymously and was completed in 1912. Last year, however, the donor, Dr. George Golding Kennedy of the Harvard class of '64, kindly consented that his name might be announced in connection with the fiftieth aniversary of the graduation of his class.

This wing contains, besides the library, the private offices of the curator, Professor B. L. Robinson, and the librarian, Miss Mary A. Day, a room for maps, files and publications, and, in the basement, a press-room for the drying and preparation of specimens, a photographic dark-room, a staff-room and store room.

At the same time, the old and wholly inadequate laboratory and auditorium, which had formed the opposite wing of the earlier structure and had been built in 1871 by the gift of Horatio Hollis Hunnewell, were taken down and replaced by the George Robert White Laboratories of Systematic Botany, a wing of much greater capacity, well arranged, well lighted and provided with complete and highly perfected equipment for its purposes. This wing, the gift of Mr. George Robert White, of Boston, contains on the ground floor two laboratories, one used by the Harvard students in systematic botany, the other by the Radcliffe students. On the second floor, there is an instrument room, a "bundle-room" for the safe storage of collections awaiting study,

labeling, distribution as duplicates, etc., also Professor M. L. Fernald's private office, and finally a large and fully furnished room, which has been placed at the service of the New England Botanical Club for its extensive and valuable herbarium.

In 1912, by a second gift from Dr. George G. Kennedy, it was possible to carry out another highly important step in the general plan of reconstruction by rebuilding of the front portion of the original structure, raising it from one and a half to three stories in height and furnishing accommodations for an exceptionally convenient mounting room, a coat-room, a private office, a room for the collection of "box material" (*i. e.*, fruits, nuts, cones, etc., which from form and thickness can not be readily affixed to the ordinary herbarium sheets), and a room for the Pterydophyta and Gramineae.

As these successive additions were made to the earlier building, the collections both of specimens and books had been so far as possible removed from the old central portion to the surrounding new and fireproof wings. Early in 1914 the last part of the old building, namely the main central room, a story and a half structure, with narrow wooden gallery, was taken down, to be replaced by a structure of greater height and much more substantial construction. This final portion of the building is now completed. It and its steel furnishings have been the gift of Mr. White, Dr. Kennedy, Mrs. William G. Weld, Miss Susan Minns and Mr. John E. Thayer. As rebuilt this main room is furnished with two steel and glass galleries, of convenient breadth, each provided like the ground floor with a series of steel herbarium cases. The room is further furnished with blocks of table-topped cases, rising to counter height; also with large steel tables, covered with battleship linoleum and of height convenient for microscopic work and plant-dissection. The room is provided with copious north light, as well as overhead light. The well lighted basement of this section of the building has been furnished as a sorting room and to that end has been provided with thirty tables which together furnish room for more than two hundred piles of herbarium sheets and thus permit even the more complicated kinds of sorting without crowding or overlapping. These basement tables are made of "transite," a neat light gray stone-like material made of Portland cement and asbestos fiber.

Although the reconstruction has thus proceeded by sections, the building has lost nothing in unity, for the whole was carefully planned at the outset and each successive portion was built with due regard to its relation to the whole structure. In the whole process of building and furnishing there has been a strenuous effort to eliminate woodwork and all combustible materials. The building itself is of brick with floors and roof of reinforced concrete. All doors, jambs, sash and window frames are bronze, copper or steel-sheathed. There is no exposed woodwork in any part of the building, inside or out. As to the furnishing there has been the same attention to safety. All the plant cases, work tables, desks, book-shelving, files, wall cabinets, etc., built to order by the Art Metal Construction Company, of Jamestown, New York, are of steel, for the most part enameled in agreeable shades of gray-green or deep green with bright or oxidized brass trimmings. Even the waste-baskets are of metal. At some points in the furnishing it has seemed best and entirely safe to make certain concessions to comfort and sentiment. Thus the chairs are still of wood, the window-shades are still of linen (though they are on metal rollers), and in the curator's office some articles of wooden furniture formerly belonging to Dr. Gray are kept in consequence of association and sentiment. Furthermore, no substitute for wooden picture frames has been found, at least none which has proved esthetically agreeable. With these trifling exceptions, however, all combustible materials have been scrupulously avoided.

The herbarium itself, *i. e.*, the great collection of dried plants mounted on sheets of cardboard, would of course prove highly inflammable, but it is preserved in cases which form, as one may say, so many fire-tight compartments, so that even were a fire by some accident started it could not possibly spread.

Although the primary ideals followed in the rebuilding of the Gray Herbarium have been those of safety, permanence and convenience of arrangement, the resulting structure though architecturally plain is by no means homely. Indeed, its good proportions, dignified simplicity and obvious solidity give it a pleasing effect. It is a building to which the architect, Mr. W. L. Mowell, of Boston, has given a good balance, but it has purposely been kept from absolute symmetry from a feeling that such initial symmetry, if attempted, would render it much more difficult to make future additions, as these prove needful with the growth of the collections.

It is a notable fact that during the complete rebuilding of the establishment, the Gray Herbarium and its library have been open as usual for consultation. Though several reshelvings and transfers of materials from one section to another have of course been needful and demanded the care and attention of the staff from time to time, nevertheless the scientific work of the staff, students and visiting specialists has proceeded with surprisingly little interruption. The building has been continuously occupied and when it is borne in mind that much of the new structure has been built upon the old foundations, it will be seen by the many botanists for whom the earlier building had many pleasant sentiments and associations, that it is perpetuated rather than replaced by the new one.

ELISHA WILSON MORSE

Elisha Wilson Morse, formerly instructor in natural history at the Bussey Institution of Harvard University and well known for his contributions to the history of domesticated animals, died in Washington, D. C., on April 18, from pneumonia.

During the past few years Mr. Morse served as a specialist in animal husbandry in the U. S. Department of Agriculture. Aside from his official duties as an associate editor of the *Experiment Station Record* and later as a scientist in the U. S. Dairy Division, he was especially active in putting the foundations of animal breeding and feeding on firmer bases. He was one of the few who had a keen appreciation of the value of applying sound biological and statistical principles to the interpretation of feeding trials.

Mr. Morse was a graduate of the class of 1897 of Harvard University, an active member of the Biological Society of Washington, the American Society of Animal Nutrition, and the Boston Society of Natural History, and a regular contributor to several standard year books and encyclopedias.

Lewis William Fetzer

SCIENTIFIC NOTES AND NEWS

The presidency of the German Association of Scientific Men and Physicians, vacant by the death of Professor Eberhard Fraas, has been filled by the vice-president, Dr. F. von Müller, professor of internal medicine at Munich.

The annual address before Sigma Xi and Phi Beta Kappa of the University of Illinois, which in previous years has been given during commencement week, will be given this year on May 4, by Dr. George Otis Smith, director of the U. S. Geological Survey. The subject is "Practical Ideals."

Dr. Julius Hirschwald, professor of geology and mineralogy in the Technical School at Berlin, has been given the doctorate of engineering by the Technical School of Dantzig, on the occasion of his seventieth birthday.

At the meeting of the Entomological Society of France, on January 27, the committee appointed to nominate an honorary member in place of the late M. J. Perez reported that, while custom decreed the election of a Frenchman to fill this vacancy, it appeared to the committee as very proper, under existing conditions, to break away for once from the traditions and custom of the society and to give this honor to M. A. Lameere, professor in the University of Brussels, as an especial testimony of the sympathy and esteem of the society for one of the most eminent representatives of Belgian entomology.

Dean Edward Orton, Jr., of the College of Engineering of the Ohio State University, has

been granted leave of absence for next year, but expects to remain at Columbus. Professor Edwin F. Coddington, of the department of mechanics, now secretary of the college, will be acting dean next year. Professor Charles C. Morris, of the department of mathematics, will fill the new position of assistant to the dean.

Dr. Edmond W. Wilson has been promoted to the position of assistant superintendent of the Boston City Hospital, filling the vacancy caused by the resignation of Dr. Frank H. Holt, who has assumed his new duties as superintendent of the Michael Reese Hospital, of Chicago.

Dr. Roy K. Flannagan, of Richmond, has been appointed assistant commissioner of health of Virginia, succeeding Dr. Allen W. Freeman, who resigned to accept the position of epidemiologist in the United States Public Health Service.

Dr. Philip J. Castleman has been appointed director of the bacteriological laboratory of the Boston Board of Health to succeed Dr. James J. Scanlon, who died a short time ago.

Dr. Albion W. Hewlett, professor of medicine at the University of Michigan, has been appointed visiting lecturer on medicine at the Harvard Medical School, and is to serve as visiting physician at the Peter Bent Brigham Hospital.

Mr. William Harper Davis, of Philadelphia, at one time assistant in psychology at Columbia and instructor and professor in philosophy and psychology at Lehigh University, secretary of the American Psychological Association, etc., who has latterly been engaged in business, has accepted the position of librarian to the Public Service Corporation of New Jersey. His address after September 1 will be the company's office, Newark, N. J.

Sir Rupert Clarke, who in the summer of last year led an expedition up the Fly River in British New Guinea, has returned to London.

Dr. David L. Edsall, professor of clinical medicine at Harvard Medical School, delivered the annual address of the Pathological Society of Philadelphia on April 22, his subject being "Bearings of Industry upon Medicine."

Since Easter, Professor George Grant MacCurdy, of Yale University, has lectured on "The Dawn of Art" for the Archeological Institute of America at Richmond, Va., Washington, D. C., and Rochester, Auburn, Syracuse and New York, N. Y.

Major Samuel Flood-Page, who was active in development of electric lighting and wireless telegraphy, died on April 7, aged eighty-one years.

Professor Karl Theodor von Heigel, president of the Bavarian Academy of Sciences, has died at the age of seventy-three years.

There have been killed in the war Dr. Fr. Ostendorf, professor of agriculture in the Technical School at Karlsruhe; Dr. Hans Hammerl, associate professor of hygiene at Gratz, and Dr. August Wolkenhauer, docent for geography at Göttingen.

The Serbian typhus epidemic may be controlled if the proper equipment is made available, according to a cablegram received on April 29 from Dr. Richard P. Strong, head of an American commission recently sent to Serbia by the American Red Cross, assisted by the Rockefeller Foundation and the Serbian relief committee. Messages received at the headquarters of the American Red Cross announce that an international board of health has been formed at Nish. The president of the international board is Prince Alexander of Serbia, the vice-president, Sir Ralph Paget of England. Dr. Strong was made medical director of the board, and the members include the heads of the French, Russian and English sanitary commissions. Dr. Strong, who is professor of tropical diseases in Harvard Medical School, appeals for more doctors and sanitary and medical equipment and declares that if Dr. William C. Gorgas, surgeon-general of the United States Army, will accept a commission in combating the typhus in Serbia, the international board just formed will make him medical director and Dr. Strong will serve as his assistant. The remainder of the American commission, which numbered ten sanitarians

and bacteriologists, have reached Salonica, Greece, and will join Dr. Strong at Nish shortly.

A MAJORITY of the members of the board of regents of the University of Minnesota, sitting as the executive committee of the board, has voted unanimously to adopt the following statement of purpose:

Although the board of regents has not as yet officially considered a proposed affiliation with the Mayo foundation, in order to make clear the policy of the board, be it voted:

"First, that in any event the regents do not enter into any permanent arrangement within four years;

"Second, that the board enter into no permanent affiliation which does not give the regents complete control, within the specific purposes of the foundation, of the endowment funds administration, and teaching."

By a vote of 36 to 31 the state senate has passed a bill as follows: The board of regents of the University of Minnesota shall not affiliate or unite with any persons, firm or corporation under any agreement, arrangement or understanding which will preclude the board from exercise of any of its functions in the educational management and control of the university or any of its colleges, schools or departments. But this act shall not be so construed as to disable the said board from employing or authorizing the employment of instructors, lecturers or teachers who shall devote a part only of their time or service to the educational work of any department of the university.

A CONFERENCE of the Massachusetts Association of Boards of Health and the State Department of Health and voluntary organizations interesting themselves in matters of public hygiene was held in Boston on April 29. The speakers at the forenoon conference were Governor Walsh, Commissioner Allan J. McLaughlin, Dr. Charles W. Eliot, Professor Irving Fisher, Miss Ella P. Crandall, executive secretary of the national organization of Public Health Nursing, and Professor William T. Sedgwick, president of the American Public Health Association. This was followed by a business session over which Professor M. J. Rosenau, of Harvard University, presided. The speakers of the afternoon, and their subjects, were: "The Control of Communicable Diseases," Dr. Eugene R. Kelley, State Department of Health; "The Relationship Between the State and Local Boards of Health," Dr. Lyman A. Jones, district health officer, Berkshire district; "The Health of the Farmer," Dr. John S. Hitchcock, district health officer, Connecticut Valley District; "The Vacation Health Problem," Dr. Adam S. MacKnight, district health officer, southeastern district; "The Continuing Problem of Vaccination," Dr. Samuel H. Durgin, former chairman of the Boston Board of Health; "The Control of Cancer," Dr. Edward Reynolds, vice-president American Society for the Control of Cancer; "Some Problems of the Health Officer of a Small City," Dr. Francis G. Curtis, health officer, Newton; "Infant Mortality from the Standpoint of the State," Dr. William Hall Coon, district health officer, northeastern district.

THE Entomological Society of France, in January, took a ballot by mail among its active membership on the question of expelling all German members. The result of the ballot, just announced, was as follows:

Total number of ballots cast	270
For the immediate expulsion of all German members	126
For their expulsion after investigation	103
Statu quo until end of hostilities	37
Provisional expulsion	1
Blank ballots	3

Inasmuch as there was no majority in the whole number of ballots cast in favor of immediate expulsion *en bloc*, the question was referred back to the council to consider the spirit and the letter of the vote and the conditions under which the German members should be expelled.

THE United States Geological Survey opened on May 1 a district office at Boston, Mass., from which investigations of the water resources of the New England states will be carried on. For several years the Geological Survey has made measurements of the flow of streams in New England, the work being carried on from the district office at Albany, N. Y. The establishment of a district office at

Boston will make possible the extension of the work and will greatly facilitate the investigations. The states of Massachusetts, Maine and Vermont are cooperating in these investigations, and a bill is pending before the legislature of New Hampshire providing for cooperation in that state. Charles H. Pierce, district engineer of the Geological Survey, will be placed in local charge of the work.

The committee on arrangements give notice of change in date in the Interstate Cereal Conference in California previously announced in Science and also a change in one of the localities from Merced to Stockton as follows: The first day's meeting will be held at Stockton, Tuesday, June 1, for inspection of San Joaquin Valley cereals, while the following three days will be spent as previously stated, namely, the second day, June 2, at Berkeley, beginning the program of the conference; June 3 at Davis, finishing the program and inspecting the university farm, and the last day, June 4, at Chico, where the program, if still unfinished, can be concluded. At this place also an inspection will be made of the Plant Introduction Garden and the cereal experiment plats of the U. S. Department of Agriculture. During the day, those who desire to do so can also go the short distance to Biggs to inspect the rice experiment farm at that place.

Since the time of Captain Cook the Hawaiian Islands have been visited by geologists and others interested in the problems of volcanoes, and much has been written concerning them. Recently the United States Geological Survey has taken up the investigation of the islands from various economic and scientific points of view and is preparing topographic maps, which are necessary for many kinds of work. It has been found that the geologic history of the islands is by no means so simple as was supposed from the earlier publications concerning them. In Professional Paper 88, "Lavas of Hawaii and their Relations," by Whitman Cross, which has just been issued, the survey is presenting a summary of what is now known concerning the lavas of all the islands. This paper is largely technical in its character, for it is intended primarily to serve as a basis for future study of the rocks by geologists, but for any one interested in the various islands and not following strictly the tourist route there is considerable general information, not to be found elsewhere. The work is a summary of earlier publications supplemented by the author's own observations on the four largest islands—Hawaii, Maui, Oahu and Kauai. It appears that there are many other kinds of lavas in Hawaii besides basalt, and many facts of association of the different lavas are of interest to students of the inner history of volcanoes. While much is yet to be learned concerning the lavas of these islands, Mr. Cross shows that present knowledge of the rocks is sufficient to throw light on some of the most vexed questions pertaining to the origin and relations of the igneous rocks of the earth. The chemical relations are discussed with particular thoroughness. Petrologists will find valuable material in this report, bearing on many problems.

The shortage of potash salts in the United States in 1914 was further accentuated by the German embargo on export at the end of January, 1915. In spite of the interruptions to the normal trade in potash salts, the imports of salts proper in 1914 amounted to 485,818,459 pounds, valued at $8,743,973, according to a statement by W. C. Phalen, just made public by the United States Geological Survey. These figures represent a decrease in quantity and value amounting to 21 per cent. and 19 per cent., respectively, compared with 1913. These figures, however, do not represent the total imports of potash salts. There should be added the quantity and value of kainite and manure salts imported, amounting in 1914 to 482,876 tons, valued at $3,397,590, making a total importation during the year valued at $12,141,563, compared with $15,241,152 in 1913—a decrease amounting to $3,099,589 or approximately 20 per cent. Potash salts constitute only one of several fertilizers imported. Bone dust, calcium cyanamid or lime nitrogen, guano, basic slag and other materials used for manure are also brought in. The total quantity of these materials including kainite and manure salts imported in 1914 was 761,896 long tons, valued at $9,921,439. In addition to the above importations, sodium nitrate

valued at $15,204,539 came into this country from foreign lands, thus bringing the total value of imports as designated above up to $33,869,951.

UNIVERSITY AND EDUCATIONAL NEWS

MR. ANDREW CARNEGIE'S gifts to the Carnegie Institute and Institute of Technology have now reached a total of $27,000,000, his latest contribution announced at Founder's Day, on April 29, being $2,700,000. Of this latter amount $1,200,000 is for new buildings and $1,500,000 for endowment. The address at the Founder's Day exercises was delivered by Dr. Romulo S. Naon, the Argentine ambassador, who spoke on "The Triumph of True Pan-Americanism and Its Relation to World Peace."

THE campaign to raise $1,385,000 for the Stevens Institute of Technology in Hoboken, N. J., has been successfully concluded. The entire indebtedness of the college, amounting to $385,000 has been cancelled, leaving $1,000,000 to be used for the erection of new buildings and for endowment.

THE University of Pennsylvania, Columbia University and the Stevens School of Technology mechanical engineering departments have received funds amounting to $5,000 each, in accordance with the provisions of the will of the late Admiral George W. Melville.

GIFTS amounting to $72,908, to be devoted to cancer research at the Harvard Medical School, have been announced. Of this sum $50,000 is provided by the will of Philip C. Lockwood, of Boston.

THE new buildings of the medical school of Washington University, St. Louis, were dedicated on April 29. The three large buildings, which contain laboratories, dispensaries, lecture rooms and libraries, cost $1,200,000 and, with the new Barnes Hospital, the St. Louis Children's Hospital and St. John's Hospital, form an important group of buildings devoted to medical and surgical purposes. Addresses were delivered by Dr. William Henry Welch, professor of pathology at Johns Hopkins University; by President A. L. Lowell, of Harvard University; by Dr. Henry S. Pritchett, president of the Carnegie Foundation for the Advancement of Teaching, and by President George E. Vincent, of the University of Minnesota.

THE University of South Dakota has completed the erection of a fireproof chemical laboratory at a cost of $100,000.

THE thirty-fourth session of the legislature of Nebraska recently adjourned appropriated the sum of $150,000 for the erection of a teaching hospital on the campus of the University of Nebraska College of Medicine at Omaha, Nebraska. The appropriation has been approved by the governor.

THE tuition fee at Harvard University has been increased to $200, which will take effect at the beginning of the year 1916–17, but will not apply to a student now registered, unless he changes his department. No infirmary, laboratory or graduation fees will be charged.

PROFESSOR IRA O. BAKER has resigned his position as head of the civil engineering department of the University of Illinois, which he has held for thirty-four years. He will continue to give a limited number of courses. Dr. F. H. Newell, consulting engineer of the U. S. Reclamation Service, has been appointed to succeed Professor Baker as head of the department of civil engineering. He entered upon his work at the university on May 1.

DR. ANDREW HUNTER, of the medical department of Cornell University, has accepted an appointment to the chair of pathological chemistry in the University of Toronto.

DR. A. A. KNOWLTON, associate professor of physics at the University of Utah, has been elected professor of physics at Reed College. It will be remembered that Dr. Knowlton was not reelected at the University of Utah because of the president's charge that he had made remarks unfavorable to the administration of the university. President Foster of Reed College went to Salt Lake City to investigate the situation. He talked with both factions of the board of regents, with many members of the faculty, including those who have resigned and those who have not, with other citizens, with students and with the president.

As a result of this investigation at first hand, Dr. Foster was convinced that Dr. Knowlton and the other men of the faculty at Salt Lake City have assumed no greater freedom of speech than every member of the Reed College faculty has as a matter of course.

DISCUSSION AND CORRESPONDENCE

ON THE PRODUCTION OF RARE GASES IN VACUUM TUBES

TO THE EDITOR OF SCIENCE: A number of investigators, among them Sir J. J. Thomson, Sir W. Ramsay, Winchester, and Collie, have found that helium and neon are produced in vacuum tubes by electrical discharges. These gases were not accompanied by argon, and therefore not due to leaks in the apparatus.[1] A thoroughly satisfactory explanation of the appearance of the gases remains to be given, although a very plausible hypothesis has been advanced by Professor Winchester. Winchester[2] finds that helium and neon are given off from aluminium electrodes only during the first few hours of long-continued discharges, and he therefore concludes that the gases must have been occluded on the surfaces from the atmosphere.

This explanation agrees with a number of facts. For example, we may explain a *second* liberation of helium and neon, sometimes noticed in vacuum tubes after many hours' continuous running, by supposing that a surface layer (*e. g.*, slag), imbedded in the metal when it was poured, becomes exposed when the electrode is partly "spluttered" away. The non-appearance of these gases when very heavy discharges (*i. e.*, large currents) are used, as in one experiment with uranium, by Collie,[3] would mean that the surface layer is spluttered away before any considerable amount of gas has been liberated.

There is an alternative explanation which fits the facts equally well, if we admit the possibility of changes of a radioactive nature taking place in an ordinary vacuum tube. But there is, in the first place, no good evidence that ordinary inactive matter can be transformed by the radiations of radioactive substances;[4] and consequently, in view of the great energy of the α particles, there is reason for supposing that the swiftest ions in a vacuum tube are equally incapable of producing disintegration of atoms (or rather, according to recent views, disintegration of nuclei; the resultant positive charge upon which determines the chemical properties of atoms[5])—unless, perhaps, there were present in the tube enormous differences of potential. Nevertheless, in an experiment by Sir W. Ramsay,[6] evidence is given which suggests an inter-relationship between the elements helium, neon and oxygen.

Certain experiments performed by the writer upon the conduction of electricity at contacts of dissimilar solids[7] show that, however carefully a metal may be cleaned in air, or in pure electrolytic oxygen, a surface film remains, sufficient to give electrical properties to such a surface, markedly different from those obtaining upon a surface that is cleaned mechanically in vacuo, or in pure electrolytic hydrogen. This being the case, it is seen that all electrodes hitherto employed in the production of rare gases have had a layer of oxide on the surface—traces of which must have remained until all the original surface had been removed by the action of the discharge.

In view of this fact it seems desirable that a tube be constructed, with electrodes similar to those used by Winchester[8] (which were found to liberate the gases rapidly); it being possible to clean these electrodes on all sides,

[1] T. R. Merton, Roy. Soc., *Proc.*, Ser. A, 90, pp. 549–53, August 1, 1914.

[2] G. Winchester, *Phys. Rev.*, N. S., Vol. 3, pp. 287–94, April, 1914.

[3] J. N. Collie, Roy. Soc., *Proc.*, Ser. A, 90, pp. 554–56, August 1, 1914.

[4] Rutherford, "Radioactive Substances and their Radiations," 1913, § 116.

[5] Rutherford, *Phil. Mag.*, Vol. 27, 6 ser., pp. 488–98, March, 1914.

[6] Sir W. Ramsay, Collie, and Patterson, *Nature*, Vol. 90, p. 653, February 13, 1913.

[7] R. H. Goddard, *Phys. Rev.*, Vol. 28, No. 6, pp. 405–28, June, 1909.

[8] Winchester, *loc. cit.*

mechanically, in vacuo; the apparatus, moreover, occupying but a small volume. The writer ventures to suggest the apparatus described below as being one which embodies the above essentials; the electrodes being substantially the same as those used by Winchester, which were in the form of circular loops of 2 mm. wire, 7 cm. in circumference, and 1 mm. apart.

Referring to Fig. 1, the electrodes are two straight parallel aluminium rods R_1, R_2, 2 or 3 mm. in diameter, and 8 cm. long. They are fastened to the glass tube T_1 by being bent around the ends of this tube, shown clearly in the horizontal section, Fig. 2.

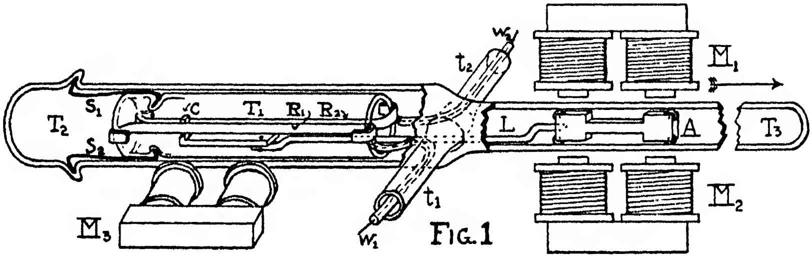

FIG. 1

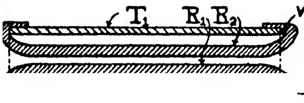

FIG. 2

FIG. 3

This tube, T_1, is held in a larger tube, T_2, by springs S_1 and S_2 (wires), the ends of which fit into dents in the glass tubes T_1 and T_2. Leading-in wires w_1 and w_2, attached to the ends of R_1 and R_2, respectively, are sealed into the two side tubes t_1 and t_2, Fig. 1; said side tubes connecting with a pump and a spectroscopic tube of the usual type.

A cutter, *C*, of hardened steel is attached by a flexible brass rod, *L*, to an armature, *A*. The cutting edge, *K*, Fig. 3, is semi-circular, to fit the rods R_1 and R_2. The armature *A* has small brass rollers at the corners, to prevent scratching the inside of T_3, and can be moved back and forth within this tube by means of electromagnets, M_1 and M_2.

While the armature, *A*, is being moved in the tube, the cutter, *C*, is pressed against R_1 and R_2 in turn by means of another strong electromagnet, M_3—the cutting stroke being in the direction of the arrow. This operation scrapes but one side of each rod, R_1, R_2. To scrape the other two sides, *A* must be turned through 180°, which is accomplished by turning M_1, M_2 through this angle. After the rods have been cleaned, *A, L, C* is moved into the tube T_3, out of the way. It will be noticed that the apparatus is, essentially, a "spoke shave" in vacuo.

By using the above tube after the electrodes have been cleaned in pure (electrolytic) oxygen, it should be possible to demonstrate conclusively the transference of oxygen into helium and neon, if such indeed exist. On the other hand, if (as seems more likely) the helium and neon which appear in vacuum tubes have previously been occluded by the metal from the atmosphere, it should be possible, by means of the apparatus, to study the rates of, and the conditions governing, such absorption.

It is by no means certain, however, that the action in question consists simply in the liberation of absorbed gases, for Sir J. J. Thomson[9] has discovered evidence of a genuine production of helium and X_3 from elements (lead) and chemical compounds (salts of sodium and potassium) which suggests an actual atomic change, if not a genuine disintegration. The

[9] Sir J. J. Thomson, Roy. Soc., *Proc.*, Ser. A, 89, pp. 1–20, August 1, 1913.

whole problem is very complicated, and it is the writer's purpose merely to call attention to the importance of surface conditions in the production of the rare gases.

ROBERT H. GODDARD

CLARK COLLEGE

THE FUNDAMENTAL EQUATION OF MECHANICS

MR. KENT, in his recent communication, invites expressions of opinion from Professor Huntington and myself regarding his method of explaining the principles of dynamics. My own view is that Mr. Kent's explanation of the effect of a constant force in giving motion to a free body initially at rest is entirely sound. It is, in fact, substantially the explanation I have long used in the classroom as a first step in establishing the fundamental equation of motion. Perhaps it is permissible to quote from my text-book on "Theoretical Mechanics," first published fifteen years ago:

> If a force of constant magnitude and direction acts, for a certain interval of time, upon a body initially at rest, the body will have at the end of the interval a velocity whose direction is that of the force, and whose magnitude is proportional directly to the force and to the duration of the interval, and inversely to the mass of the body.

Since mass has already been defined as quantity of matter, this statement is seen to be identical in meaning with Mr. Kent's statement that "the velocity varies directly as the time and as the force, and inversely as the quantity of matter."

Mr. Kent's equation $V = KFT/W$ is entirely satisfactory and sufficient so long as our study is confined to the case in which a force whose direction and magnitude remain constant acts upon a body otherwise free and initially at rest. This is, however, a very exceptional case. The fundamental principle in its generality can be expressed only by introducing the notion of *instantaneous rate of change of velocity, i. e.,* acceleration. When this is done Mr. Kent's statement quoted above must be replaced by the statement that "the acceleration varies directly as the force and inversely as the quantity of matter," while his equation $V = KFT/W$ is superseded by the more general one $a = KF/W$. This is identical with equation (5) of my former communication,[1] except that quantity of matter is there represented by m instead of W.

To pass from the equation

$$\text{acceleration} = K \times \frac{\text{quantity of matter}}{\text{force}} \qquad (1)$$

to the equation

$$\text{acceleration} = \frac{\text{quantity of matter}}{\text{force}} \qquad (2)$$

of course requires that units should be defined so that unit force acting on unit quantity of matter causes unit acceleration. Mr. Kent regards this as an objection to equation (2). If the objection is valid a similar one seems to apply to his own procedure. His equation

$$V = 32.1740 \frac{FT}{W}$$

is true only because his unit force is defined as the force which would give a pound of matter an acceleration of 32.1740 ft./sec.^{2} The statement that the accurate value $K = 32.1740$ is found as the result of "the most refined experiments, involving precise measurements of both F and W, and of S, the distance traversed during the time T, from which V is determined" is quite misleading. The stated value of K is not based upon any refined measurements of the character described, but upon a purely ideal definition of the unit force; just as the value $K = 1$ results from a different ideal definition.

If there is any reason for preferring the set of units which makes $K = 32.1740$ to that which makes $K = 1$ in equation (1), it is not because the former is any more easily understood than the latter. "The force which, acting upon a pound of matter, would cause an acceleration of 32.1740 ft./sec.^{2}" is the same kind of a definition as "the force which, acting upon a pound of matter, would cause an acceleration of 1 ft./sec.^{2}" It is true that the former of the two units of force thus defined

[1] SCIENCE, April 23, 1915, p. 609. It is well known that Mr. Kent objects to the use of the word mass for quantity of matter; my present object is to make my meaning clear rather than to invite an unprofitable discussion over a purely verbal question.

has nearly the value of that used in the "ordinary English system," and this may be regarded as an advantage.[2] The unit in "ordinary" use, however, is not and never will be the exact "standard" pound, because for almost all practical purposes the refinement of distinguishing between "local" and "standard" gravity-pull is of no importance. For precise work there appears to be absolutely no choice between the system which makes $K = 32.1740$ and that which makes $K = 1$ except that the latter simplifies the fundamental equation and all equations depending upon it.

Mr. Kent thinks the C.G.S. system "should not be inflicted on young students" because it is "only used in higher physical theory." The great majority of those who study mechanics are preparing for the profession of engineering. In view of the fact that in a large and increasingly important part of the present-day field of engineering—applied electricity—the units employed are based upon the C.G.S. system, it is difficult to assent to the view expressed by Mr. Kent on this point.

L. M. HOSKINS

STANFORD UNIVERSITY,
March 29, 1915

[2] The same advantage may be retained with the simpler equation (2) if we permit quantity of matter to be expressed in terms of a unit other than the pound. Why the reduction of quantity of matter from pounds to units 32.1740 times as great as the pound should be regarded as more puzzling than the reduction from pounds to tons or the reduction of a length from inches to feet, is something I have never been able to comprehend.

CONDITIONS AT THE UNIVERSITY OF UTAH

TO THE EDITOR OF SCIENCE: In view of the fact that seventeen members of the faculty of the University of Utah have resigned their positions on the ground that it seemed to them "impossible to retain their self-respect and remain in the university," the council of the American Association of University Professors has authorized the appointment of a committee of inquiry to report upon the case. At the request of the president, the secretary of the association recently spent four days in Salt Lake City investigating the situation in the university and collecting evidence to be laid before the committee. The special purposes and scope of the investigation are indicated in the extract from the letter addressed by the secretary of the association to the president of the university, which was printed in the issue of SCIENCE for last week.

The report of the committee of inquiry will be prepared and published at as early a date as is practicable. It is the purpose of the committee to present all the pertinent facts so fully in its report that university teachers may judge for themselves as to the administrative methods, and the conditions of professorial service, in the university. We make this statement in order that any one who is considering either the acceptance of a position in the university or the recommending of others for such a position, may look forward to a full knowledge of the situation in the near future, and may postpone immediate action in case he deems such knowledge advisable before reaching a final decision.

JOHN DEWEY,
President of the American Association of University Professors,
A. O. LOVEJOY,
Secretary of the American Association of University Professors,
EDWIN R. A. SELIGMAN,
Chairman of the Committee of Inquiry

April 30, 1915

UNNATURAL HISTORY

TO THE EDITOR OF SCIENCE: I am sure your readers will be interested and instructed, and the monotony of their daily grind relieved, by the following information regarding hitherto unsuspected details in the life history of the kangaroo. These facts were given out by a university student in response to the question: "Explain how the young kangaroo obtains its nourishment."

"Immediately after birth they are swallowed by the mother and finally lodged directly over the breasts, the teats being directed inwards.

Here in their mother's heart the young marsupials are nourished for some time, when they are expelled from the mother fully developed and ready to begin life."

C. C. Nutting

SCIENTIFIC BOOKS

Infection and Resistance. By Professor Hans Zinsser, Professor of Bacteriology at the College of Physicians and Surgeons, Columbia University, New York City. The Macmillan Company. 1914. Pp. 546. Illustrated. $3.50.

This work is conspicuously the most thorough and modern original treatment of the subject of infection and immunity that we have in the English language. The author's own work in the field of immunology, citations to which are frequently made in the text, makes the book authoritative.

We find in the book an exhaustive and impartial analysis of the enormous accumulation of recent work in this field with a wealth of references to original sources given at the bottom of the pages. The survey of the subject is complete, and yet each chapter is a unit in itself, making the book a convenient reference in which to gain a knowledge of any one phase of immunity. This unit arrangement of the chapters has necessitated some repetition, but not to an extent to become boresome.

The text is not intended to be elementary or summary and can not be recommended for the average reader or undergraduate student. It can be most cordially recommended to practitioners, teachers, laboratory workers and especially as a text for medical students for whom it is primarily intended.

Starting with the general problem of Virulence, the author discusses successively the Bacterial Poisons, Natural and Acquired Immunity, Antitoxins, Cytolysis, Complement and Diagnosis, Agglutination, Precipitation, Phagocytosis (four chapters), Anaphylaxis (three chapters), Therapeutic Immunization, and a chapter on Abderhalden's Work on Protective Ferments. Dr. Stewart W. Young has been invited to write a concluding chapter on Colloids, which gives a comprehensive idea of the nature of this state of matter, and the relation of colloids to biological problems.

The chapter on Therapeutic Immunization in Man might be criticized on account of its brevity in contrast to the rest of the book. It seems to the reviewer as though it could be made more effective even in the space allotted by the introduction of more data to show the efficacy of our marvelous advances in immunology.

C. M. Hilliard

The Differentiation and Specificity of Starches in relation to Genera, Species, etc. Stereochemistry applied to Protoplasmic Processes and Products, and as a Strictly Scientific Basis for the Classification of Plants and Animals. By Edward Tyson Reichert, M.D., Professor of Physiology in the University of Pennsylvania, Research Associate of the Carnegie Institution of Washington. In two parts. Published by the Carnegie Institution of Washington, Washington, D. C. 1913. Pp. 900, plates 102.

The author intends that the present memoir on starches shall have a relation to the memoir on hemoglobins worked out by Reichert and Brown and reviewed in Science (January 27, 1911). If there is a relationship between these two memoirs it is rather in what Dr. Reichert has attempted to perform than in what he has succeeded in accomplishing. The two memoirs are so different that a comparison of them is well-nigh impossible. In the one, we almost see the master and in the other the novice. The memoir on hemoglobins represents a painstaking research and is an important contribution to biology. The memoir on starches, in its present form, is hardly worthy to be classed as research, particularly in view of the splendid monograph of Naegeli which has been reputed to be among the greatest investigations of the last century. In the work on hemoglobins, through the cooperation of Dr. Brown, the exact methods of physical crystallography have been employed and it is to be expected that in the hands of different investigators confirmatory results will be obtained in the examination of the crystals of the various hemoglobins. In the present memoir on

starches, Dr. Reichert has replaced exact quantitative methods by those which under certain conditions might have a confirmatory value, but certainly are of no specific importance, as will be shown later, so that independent investigators may be able to confirm his observations and distinguish one species or genera from another. It is only necessary to read carefully a work like that of Solereder on the "Systematic Anatomy of the Dicotyledons" to appreciate the nature of the task that confronts an investigator who attempts to solve a fundamental problem such as Dr. Reichert has attempted.

Before critically examining the work it may be desirable to mention the contents of these two large volumes. Nearly 300 pages are devoted to a résumé of the important monographs and some of the important papers on the starches. The best part of this portion of the work is the translation from Naegeli's monograph on "Die Stärkekörner," giving his classification of some 1,200 starches. This comprises nearly 100 pages. Any review of the literature on starch must be unsatisfactory, as it is likely to be inadequate, and this is especially true of the summary by Dr. Reichert. It would have been far better in a memoir like this had Dr. Reichert placed in chronological order the literature which he cited so that it might be consulted or referred to by the student and the investigator, particularly if he intended this to be a work of reference on starches.

In Chapter VI. we find a discussion of some of the methods that the author considers might be employed in an investigation of this character and which involved the study of over 300 starches, which he isolated from as many different plants. He employed essentially six different methods: (1) Histological method, involving the study of the form, markings and size of grains. (2) Polariscopic properties, *i. e.*, reactions using polarized light both with and without selenite. (3) Iodine reaction, using 0.125 per cent. and 0.25 per cent. of Lugol's solution. (4) Action with aniline dyes, using gentian violet and safranin, using 5 c.c. of a solution containing 0.05 per cent. of aniline dye. (5) Temperature of gelatinization, which was determined with a specially constructed water bath, and in which was placed test tubes containing a small quantity of starch with 10 c.c. of water. (6) Several swelling reagents were used, viz., chloral-hydrate-iodine solution, chromic acid in the form of a 25-per-cent. solution; ferric-chloride solution consisting of equal parts of a saturated solution in water, and Purdy's solution, which was made up of equal parts of the standard solution and water.

In the preparation of the starches, the material was comminuted, mixed with water, strained through cheese cloth, centrifugalized and washed with water and re-centrifugalized to remove as much impurity as possible.

The various starches were photographed both with and without polarized light. Some of these photographs are very excellent and in some instances may be of some scientific value. For the most part, however, unless photographs of starches are supplemented with drawings they lose much of their interest and significance.

Great stress is laid by the author on the different reaction intensities of the several reagents on any given starch and these have been set forth graphically in the form of curves with a view of affording a clear presentation of the quantitative reaction peculiarities of the starches and permit of comparison between them. "In the construction of the charts the abscissas have been used to express the degree of polarization (*P*), the intensity of the iodine reaction (*I*), the intensity of the gentian violet reaction (*GV*), the intensity of the safranin reaction (*S*), the temperature of gelatinization (*T*), the time-reaction of chloral hydrate-iodine (*CHI*), the time-reaction of chromic acid (*CA*), the time-reaction of pyrogallic acid (*PA*), the time-reaction of ferric chloride (*FC*), and the time-reaction of Purdy's solution (*PS*). The letter or letters as above given in parentheses each lie at the head of a special column or ordinate, and indicate the agent, while those of the abscissas give the values of the reactions. The letters of the column under *P* indicate, respectively, very

high, high, fair, low and very low; and under *I, GV* and *S*, very dark, dark, fair, light and very light."

The procedure in the examination of the several starches by Dr. Reichert is as follows: The temperature of gelatinization and intensity of color of aniline dyes was determined by placing *a small amount of starch* in a test tube containing in the one case 10 c.c. or an excess of water and in the other case 5 c.c. or an excess of solution of the dye. In using iodine solution he does not say how much starch was employed, but merely states that "the starch was placed on a slide and one or two or more drops of the iodine solution added, the whole covered with a cover slip." In the use of swelling reagents we read that "a small amount of starch is placed on a slide, several drops of the reagent added, a cover glass put on, and the progress of events examined under the microscope." Granting that there is a certain variation to a limited extent in the shade and intensity of color produced by certain reagents with some of the starches,[1] these differences will only hold when definite quantities of starch and definite quantities of reagent are used. From the statements in the foregoing paragraph showing the method of making microscopic mounts, it is apparent that Dr. Reichert did not bear in mind this fundamental fact as he did not use definite quantities of starch with definite quantities of reagent. One illustration is sufficient to show the weakness of his technique and the untrustworthiness of his results. Let the worker make four mounts, using varying quantities of starch and iodine solutions as follows: (1) 0.003 gm. of starch and 1 drop of iodine solution; (2) 0.006 gm. of starch and 1 drop of iodine solution; (3) 0.003 gm. of starch and 2 drops of iodine solution; (4) 0.006 gm. of starch and 2 drops of iodine solution. If a solution be employed containing 0.25 per cent. of Lugol's solution as adopted by Dr. Reichert, the intensity of color will not be as pronounced as if a reagent containing 0.50 per cent. of Lugol's solution be used. In any case the reactions in the several mounts will show considerable variation, a more intense blue coloration being usually discernible in mounts containing 0.003 gm. of starch and 2 drops of reagent and weakest in mounts containing 0.006 gm. of starch and 1 drop of reagent. Nearly equally as striking differences will be obtained when using varying quantities of starch with two or more drops of the swelling reagents employed by Dr. Reichert. A more noticeable and complete swelling being produced when less starch (0.006 gm.) is employed, with an excess of reagent (4 drops), and a partial or incomplete gelatinization always being observable when an excess of starch (0.012 gm.) are used with a minimum quantity (2 drops) of the swelling agent. When we consider the nature of starch these varying results are to be expected unless a quantitative relation be borne in mind between the amount of starch and the number of drops of reagent employed.

[1] *Bot. Gaz.*, October, 1905.

The method employed by Dr. Reichert in determining the temperature of gelatinization and of coloration with aniline dyes might have been applied to the use of other reagents. In the designation of intensity of color reaction with aniline dyes and iodine, Dr. Reichert was unfortunate in adopting an arbitrary scale of very dark, dark, fair, light and very light, as hardly any two observers would agree as to whether a color was dark or fair, etc. It would have been a great deal better had there been an accurate color scale embodied in the publication so that Dr. Reichert's work could be confirmed.

In view of these serious criticisms involving a crude technique and one which is liable to give discordant results in the hands of different investigators we must conclude that Reichert's work has added practically nothing to the interesting question of stereoisomerism of the starches, nor can it be considered as a serious contribution to our knowledge of the specificity of starches in relation to genera, species, etc. Apparently it will be very difficult for any one very soon to add anything of a fundamental character or in a comprehensive way to the study of starches and that can be at all compared to the monumental work on "Die

Stärkekörner" written by Naegeli in 1874. This does not mean that there are not many interesting and important problems connected with the study of the starch grain, but the solution of these can be accomplished only at the hands of the experienced specialist engaged in research or under the direction of a master mind.

HENRY KRAEMER
PHILADELPHIA COLLEGE OF PHARMACY,
March 27, 1915

SPECIAL ARTICLES

THE OSMOTIC PROPERTIES OF DIFFERENT KINDS OF MUSCLE

IN two recent articles[1] I have pointed out that the osmotic properties[2] of the smooth and striated muscle of the frog and of the clam's adductor muscle were strikingly different. Loeb suggests[3] that the differences observed by me might be due to the fact that "the smooth muscle of the stomach . . . can not be obtained in as natural a condition as . . . striped muscle . . . ." Still more recently, in an article published from Loeb's laboratory, v. Körösy[4] has enlarged upon Loeb's suggestion and has described some experiments purporting to uphold it.

The reasons for thinking that the differences in the osmotic behavior of the three types of muscle mentioned above can not be due to any difference in the manner of their preparation seem to me very cogent; they have already been largely given in my articles dealing with the subject. But it has not previously been possible to give them completely or to bring them together into one place, and, in view of the suggestions of Loeb and v. Körösy, it seems worth while to do this now.

The first difficulty which one meets in comparing the reactions of smooth and striated muscle is that cutting across the fibers or removing the "natural surface" does not have the same effect on the two tissues. Striated muscle goes almost immediately into rigor in the neighborhood of a cut across its fibers. This condition is accompanied by acid formation,[5] by swelling, and by the loss of irritability and of the characteristic osmotic properties of the tissue; it spreads gradually from the point of injury to other parts. Cutting across the fibers of smooth muscle causes a contraction which is soon followed by relaxation; there is no tendency toward acid formation, swelling or loss of irritability either in the neighborhood of the cut or in any other portion of the tissue. These facts, which are ignored by Loeb and v. Körösy, are very significant; they suggest at the outset, what is confirmed by all my subsequent work, that the fibers of striated muscle are surrounded by characteristic semi-permeable surfaces, injury to which produces profound changes in the tissue; and that no such surfaces exist in the case of smooth muscle. They are incompatible with the view that the osmotic properties of the tissues are alike. Finally, they show that my preparations of smooth muscle, in spite of the fact that their fibers have been cut, are more nearly comparable to uninjured than to injured preparations of striated muscle.

But one need not stop here. The rigor, etc., produced in the neighborhood of a cut across the fibers of striated muscle spreads only gradually from the injured to the uninjured regions; hence, if the injured area be proportionally small, the preparation will react osmotically for the first hour or so very nearly like an uninjured muscle. If a frog's sartorius be cut across its middle, either half of the muscle will have about the same proportions of "natural surface" and "unnatural surface" as the preparations of frog's stomach muscle used in my experiments. Such a cut sartorius reacts for the first hour in all respects very much like an uninjured sartorius. The strikingly different osmotic reactions characteristic of smooth muscle showed themselves

[1] Meigs, *The Journal of Experimental Zoology*, Vol. 13, p. 497, 1913; *The Journal of Biological Chemistry*, Vol. 17, p. 81, 1914.

[2] By "osmotic properties" I mean those properties of the tissues which determine the characteristic changes of weight undergone by them when immersed in various solutions.

[3] Loeb, SCIENCE, N. S., Vol. 37, p. 430, 1913.

[4] V. Körösy, *Zeitschrift für physiologische Chemie*, Vol. 93, pp. 171 *et seq.*, 1914.

[5] Fletcher and Hopkins, *The Journal of Physiology*, Vol. 35, pp. 261 *et seq.*, 1907.

in my preparations long before the end of the first hour.

Further, the effects of cutting across the fibers or of exposing an "unnatural surface" in smooth muscle may be studied experimentally by comparing the reactions of preparations which have been cut in many places with those of others which have been cut as little as possible. Such experiments show that cutting has no perceptible effect after the first few minutes; for the first few minutes it produces a very slight tendency for the preparation to lose fluid. Examination of the differences in the osmotic reactions of smooth and striated muscle under different circumstances shows that these differences can not be explained as the result either of this or of any other conceivable effect of injury. Smooth muscle, for instance, swells more rapidly than striated muscle in Ringer's solution, but less rapidly in half-strength Ringer; it would be a very extraordinary hypothesis that these opposite differences were both the effects of injury. Still less can the swelling of smooth muscle in solutions of non-electrolytes and the peculiar changes of weight undergone by it in double-strength and half-strength Ringer solution be explained as the result of injury by any one who will take the trouble to make a careful study of these phenomena.

In order to obtain a preparation of striated muscle comparable to my preparations of smooth muscle v. Körösy pared off the surface layers of a frog's gastrocnemius with a razor and used the core which was left. This is, to say the least, a severe test. The gastrocnemius is for the most part composed of short fibers which run diagonally across it and end in the fascia covering its surface. The procedure adopted by v. Körösy would therefore give a surface largely or entirely composed of the cut ends of the muscle fibers. My preparations of stomach muscle were covered on one side by the serosa and on the other by a part of the connective tissue which lies between the muscular and mucous coats of the stomach; these two surfaces made up about nine tenths that of the whole preparation, and were certainly as "natural" as that which is left covering a striated muscle after it is torn away from the skin and from the neighboring muscles.

V. Körösy tried only one experiment which bears on the osmotic differences between the smooth and striated muscle of the frog. He immersed his muscle core in 0.23 M saccharose solution and found that it gained weight fairly rapidly. It is to be presumed that lactic acid was being rapidly produced over the whole surface of v. Körösy's preparation,[6] and it is not surprising, therefore, that it should gain weight in either 0.23 M saccharose solution or in any other solution nearly isosmotic with frog's blood. But, in view of the considerations given above, it can hardly be supposed that this experiment shows that the osmotic properties of smooth and striated muscle are alike.

V. Körösy also immersed his gastrocnemius cores in various hypertonic NaCl solutions, and found that they lost weight in the early stages of their immersion.[7] These results are to be compared with mine on the adductor muscle of the clam, which had already begun to gain weight after five minutes' immersion in a strongly hypertonic NaCl solution.[8] My preparation was certainly not any more injured than v. Körösy's in this case, yet under comparable experimental conditions it gained weight and his lost. I do not understand, therefore, why he thinks that his experiments with the gastrocnemius core indicate that the osmotic properties of the various kinds of muscle under consideration are alike, nor do I understand his remark on page 173, which I take to mean that we need information about the changes of weight undergone by clam's muscle in the early stages of its immersion in hypertonic solutions. We already have detailed information on this point.[9]

[6] Fletcher and Hopkins, *The Journal of Physiology*, Vol. 35, pp. 261 *et seq.*, 1907; Laquer, *Zeitschrift für physiologische Chemie*, Vol. 93, p. 69, 1914.

[7] *Loc. cit.*, pp. 170 and 171 and Table 11.

[8] Meigs, *The Journal of Biological Chemistry*, Vol. 17, Experiment 17, p. 97, 1914.

[9] Meigs, *loc. cit.*, Experiments 3 and 17, pp. 95 and 97.

With regard to v. Körösy's supposition (pp. 172 and 173) that my preparations of frog's stomach muscle were contaminated with acid, I can only say that it is incorrect. I took particular pains to avoid contamination of the muscle with the stomach contents; the preparations were decidedly alkaline to litmus at the beginnings of the experiments and remained so for at least twenty-four hours.

It seems to me that any further attempt to show that the smooth and striated muscle of the frog and the adductor muscle of the clam are all equally subject to the "law of Avogadro-van't Hoff" should be based on experiments on all three kinds of muscle and on careful consideration of the data already at hand, rather than on experiments confined to striated muscle and backed up only by experimentally unfounded suppositions.

EDWARD B. MEIGS

THE WISTAR INSTITUTE OF ANATOMY AND BIOLOGY

ON THE TAXONOMY OF THE PROCYONIDÆ

WITHIN recent time I have, through the courtesy of the United States National Museum and the Academy of Natural Sciences of Philadelphia, enjoyed the opportunity of making a comparative study of the skeletons of the procyonine mammals of America, and that of the panda of the Old World. These researches have resulted in the production of a memoir setting forth in full complete and comparative accounts of the osteology of all these species and genera, as well as thorough studies of their several dental armatures. This memoir carries with it thirteen quarto plates, upon which are to be found eighty-seven photographic figures, giving all the skulls and many other bones of the skeletons of these procyonine species, together with the skull of *Ailurus fulgens*. In all cases the figures are given natural size.

As there is usually some little delay in the publication of memoirs of this class, I have thought best to publish here an advance abstract, setting forth some of my findings with respect to this group in the matter of their classification. All descriptive details, as well as the large number of osteological figures of the Procyonidæ, will be available to mammalogists later on—that is, at such time as I can arrange for the publication of this work in its entirety.

As to the panda, I have said: "Judging from the characters presented on the part of its teeth; its skull, with the presence of the alisphenoid canal, and its Asiatic habitat, it is clear that *Ailurus fulgens*, the panda, is but remotely related to such forms as the raccoons, the coatis, or the kinkajous. Wherever it belongs, it does *not* belong in there. Having studied only the teeth and skull of a single individual, I am not prepared to say much in regard to its affinities; but I am of the opinion that it belongs, as a superfamily, Ailuroidea, between the bears and the procyonine forms. Possibly *Ailuropus* may be the connecting type here—that is, with the ursine series.

Apart from their special character differences, which have been given in detail above, the dental formulæ agree in *Bassariscus*, *Nasua* and *Bassaricyon*, while in *Potos* the formula is different. This fact alone is sufficient evidence to convince a mammalogist that the Kinkajous are, at least to this extent, more or less removed from the more typical raccoon group. In *Bassaricyon*, although the formula is the same as in a raccoon, the teeth differ markedly in their special characters. Especially is this the case with respect to their morphology and extremely feeble tuberculation.

In not a few particulars its cranium and mandible agree with that part of the skeleton in *Bassariscus*, though the curvature of the superior cranial line is more as we find it in *Procyon*—that is, in *Bassaricyon* it is not so flat and straight as it is in the ring-tailed bassaris.

Not having examined the entire skeleton, my opinion is given tentatively in so far as the taxonomical position of *Bassaricyon* is concerned; but with the morphology of its teeth and skull before us, it is clear that it possesses characters common to both the true

raccoons as well as to *Bassariscus,* and therefore belongs in some subdivisional group by itself. This is likewise true of *Nasua,* for, although the morphology and characters of its skull, axial skeleton and limbs are procyonine, it nevertheless departs very decidedly from the true raccoons in not a few of its osteological characters. This is seen in the elongate form of the skull in *Nasua* with its relatively smaller bullæ; the mesial foramen between the anterior palatine foramina; the upturned nasals, but more particularly the great differences to be found in the long bones of its skeleton; their proportional lengths and their characters, as well as the difference in form of the scapula and pelvis. These *constant* differences in the skeleton among *Bassariscus, Procyon* and *Nasua* are supergeneric and must be so considered.

Coming to *Potos,* we not only find the radical difference in the dental armature as compared with all the other genera; but its skull, although exhibiting certain general procyonine characters, is, in its form, entirely different from the skull of *Procyon,* or of *Nasua,* or the bassaris, or of *Bassaricyon.* The skull of a kinkajou is as short as the skull in a domestic cat; the mastoid process is entirely aborted; the paroccipital stands away from the bulla on the same side; tympanics short; frontal sinuses extremely small; and in the mandible the complete coossification of the horizontal rami at the symphysis, with the lower border of the bone concave. There are likewise numerous differences in the axial skeleton which have been fully enumerated above. In short, *Potos,* with its short skull; prehensile tail; different vertebral column; and other departures in its skeleton from the more closely related genera noted above, belongs strictly in a group by itself—that is, the several species do, and, while evidently procyonine in its characters and relationships, it is nevertheless well removed from the more typical raccoons, and the further we study its habits and anatomy, the more evident does this fact become.

In short, this group of mammals constitutes a superfamily Procyonoidea, divisible into two families—the Procyonidæ and the Potosidæ, with the former family divided into three subfamilies, Bassarisinæ, Bassaricyoninæ and Nasuinæ, thus:

Superfamily	Families	Subfamilies
Procyonoidea	Procyonidæ	Bassarisinæ
		Bassaricyoninæ
		Nasuinæ
	Potosidæ	Protosinæ

and this I believe to be their true relationships in nature.

R. W. Shufeldt

Washington, D. C.,
December 24, 1914

THE NATIONAL ACADEMY OF SCIENCES

The sessions of the annual meeting of the academy were held in the Oak Room of the Raleigh Hotel and in the United States National Museum, Washington, D. C., on April 19, 20 and 21, 1915.

Sixty-one members were present, as follows: Abel, Becker, Bell, Boltwood, Britton, Bumstead, Cattell, Chamberlin, Chittenden, Clark (W. B.), Clarke (F. W.), Clarke (J. M.), Conklin, Coulter, Cross, Dall, Davenport, Davis, Day, Donaldson, Fewkes, Frost, Hague, Hale, Harper, Harrison, Hayford, Hillebrand, Holmes, Howell, Jennings, Loeb, Mall, Meltzer, Mendel, Merriam, Michelson, Moore, Morgan, Morley, Nichols (E. L.), Noyes (A. A.), Noyes (W. A.), Osborn (H. F.), Osborne (T. B.), Parker, Pickering, Pirsson, Ransome, Reid, Remsen, Schuchert, Scott, Smith (Erwin F.), Walcott, Webster, Welch, Wheeler, White, Wood (R. W.), Woodward.

The following scientific program was carried out in full:

"Localization of the Hereditary Material in Germ Cells," by Thomas H. Morgan.

Problems of Nutrition and Growth:

"Stimulation of Growth," by Jacques Loeb.

"Specific Chemical Aspects of Growth," by Lafayette B. Mendel.

"Basal Metabolism during the Period of Growth," by Eugene F. Du Bois, medical director, Russell Sage Institute of Pathology (by invitation of the Program Committee).

"Retention in the Circulation of Injected Dextrose in Depancreatized Animals and the Effect of an Intravenous Injection of an Emulsion of Pancreas upon this Retention," by I. S. Kleiner and S. J. Meltzer.

"The Electrical Photometry of Stars," by Joel Stebbins, Draper Medallist.

"A Vortex Hypothesis of Sun Spots," by George E. Hale.

"The Spectroscopic Binary, Mu Orionis," by Edwin B. Frost.

"One-Dimensional Gases and the Experimental Determination of the Law of Reflection for Gas Molecules," by Robert W. Wood.

"The Relations Between Resonance and Absorption Spectra," by Robert W. Wood.

"On the Polarized Fluorescence of Ammonio-Uranyl Chloride," by Edward L. Nichols and H. L. Howes.

"Atomism in Modern Physics," by Robert A. Millikan (by invitation of the Program Committee).

"Problems Associated with the Origin of Coral Reefs, Suggested by a Shaler Memorial Study of the Reefs of Fiji, New Caledonia, Loyalty Islands, New Hebrides, Queensland and the Society Islands, in 1914," by William Morris Davis.

"Inorganic Constituents of Marine Invertebrates," by F. W. Clarke.

"Amphibia and Reptilia of the American Carboniferous," by Roy L. Moodie (introduced by H. F. Osborn).

"Human Races of the Old Stone Age of Europe, the Geologic Time of their Appearance, their Racial and Anatomical Characters," by Henry Fairfield Osborn and J. Howard McGregor.

"On the Fossil Algæ of the Petroleum-yielding Shales of the Green River Formation," by Charles A. Davis, geologist, Bureau of Mines (by invitation of the Program Committee).

"The Forests of Porto Rico," by Nathaniel L. Britton.

"Pictures on Prehistoric Pottery from the Mimbres Valley in New Mexico and their Relation to those of Casas Grandes," by J. Walter Fewkes.

"Inheritance of Temperament," by Charles B. Davenport.

"Inheritance of Huntington's Chorea," by Charles B. Davenport.

"The Fur Seal Herd of the Pribilof Islands," by George H. Parker, official representative of the academy upon the Special Commission appointed by the President of the United States to study and report upon the Alaskan Fur Seals during the summer of 1914.

"The Evolution of the Earth," by Thomas Chrowder Chamberlin, of the University of Chicago, William Ellery Hale lecturer.

The president announced that the preparation of biographical memoirs of deceased members had been assigned as follows:

Bowditch, Henry P.	Cannon, Walter B.
Davidson, George	Existing biography approved.
Gould, B. A.	Comstock, George C.
Mitchell, Henry	Hayford, John F.
Mitchell, Silas Wier	Welch, William H.
Chandler, Seth Carlo ...	Elkin, William L.
Peirce, Benjamin Osgood.	Hall, E. H.
Holden, Edw. Singleton.	Campbell, W. W.
Hill, George William ...	Brown, E. W.
Gill, Theodore Nicholas..	Dall, William H.
Minot, Charles Sedgwick.	Donaldson, Henry H.
Billings, John S.	Garrison, Fielding H.

The president announced the death since the autumn meeting of one foreign associate:

Auwers, G. F. J. Arthur, January 24, 1915, elected 1883.

Reports of the President and Treasurer

The reports of the president[1] and treasurer[2] for 1914 as transmitted to the senate of the United States by the president of the academy were presented in their printed form and approved.

Report of the Home Secretary

The President of the National Academy of Sciences:

Sir: I have the honor to present the annual report of home secretary of the National Academy of Sciences for the year ending April 21, 1915.

The memoir of the National Academy of Sciences, Volume 12, Part 1, and bearing the title, "Monograph of the Bombycine Moths of North America," by A. S. Packard, edited by T. D. A. Cockerell, has been published and distributed to the members, foreign associates, institutions and reference libraries; Volume 12, Part 3, of the *Memoirs,* entitled "The Turquoise," by Joseph E. Pogue, has also been published and distributed to the members; Part 2 of this same volume entitled, "Variations and Ecological Distribution of the Snails of the Genus *Io,*" by Charles C. Adams, has received final consideration, and is now waiting to be bound at the Government Printing Office; the memoir forming Volume 13, being "A Catalogue of the Meteorites of North America," by Oliver C. Farrington, only awaits press work and binding before it is issued.

The biographical memoirs of John Wesley Powell, Charles A. Schott and Miers Fisher Longstreth have been published. The publication of the memoir of J. Peter Lesley, by Dr. William M. Davis, has been approved by the committee on publication, and the biography of Henry Morton,

[1] Report of the National Academy of Sciences for the year 1914, pp. 11–56.

[2] *Idem,* pp. 57–65.

by Edward L. Nichols, has been printed and awaits the portrait.

Three members have died since the last annual meeting: Theodore Nicholas Gill, on September 25, 1914, elected in 1873; Charles Sedgwick Minot, on November 19, 1914, elected in 1897, and Henry Lord Wheeler, on October 30, 1914, elected in 1909.

Of our foreign associates, Eduard Suess died on April 26, 1914, elected in 1898; August Weismann, on November 5, 1914, elected in 1913; Hugo Kronecker, on June 6, 1914, elected in 1901; G. F. J. Arthur Auwers, on January 24, 1915, elected in 1883.

There are 134 active members on the membership list, 1 honorary member, and 43 foreign associates.

Arthur L. Day,
Home Secretary

Report of the Directors of the Bache Fund

To the President of the National Academy of Sciences:

Sir: The serious illness of Dr. Charles S. Minot, the chairman of the board of directors of the Bache Fund, made it difficult to carry on the work of the board for several months. His death in November last left a vacancy hard to fill, as he was most conscientious in the performance of his duties. After careful consideration the two remaining members of the board elected Professor Ross G. Harrison the third member and he accepted. In turn the board elected the undersigned chairman.

Since the last annual meeting of the academy the following appropriations have been made:

No. 182, W. C. Kendall, $600. April 30, 1914. Toward the expenses of illustrations in color and incidental expenses in connection with part II. (Salmonidæ), fishes of New England, to be published by the Boston Society of Natural History.

No. 183. C. G. Abbot, $250. June 29, 1914. To complete and test on Mt. Wilson in California an apparatus consisting of a concave cylindric mirror of about 100 sq. ft. surface adapted to heat oil to circulate through a reservoir containing ovens and water pipes, and thereby to utilize solar radiation for cooking and for heating water for domestic purposes.

No. 184. P. W. Bridgman, $500. September 14, 1914. To continue the work on high pressures, especially to investigate the phase changes brought about in various substances by very high pressure.

No. 185. Robert W. Hegner, $160. December 26, 1914. To determine the visible changes that take place during the differentiation of the germ cells in the embryos of hermaphroditic animals, and to discover, if possible, the cause of these changes.

No. 186. J. Voûte. $800. February 9, 1915. For the determination of parallaxes of southern stars by transits. The Bache Fund has heretofore granted $1,000 for this research. It is conducted at the Royal Observatory, Cape of Good Hope, wholly at the expense of Mr. Voûte, except for these grants.

No. 187. H. H. Lane, $500. April 14, 1915. To make a comparative study of the embryos and young of various mammals in order to determine, by physiological experimentation and morphological observations, the correlation between structure and function in the development of the special senses.

Ira Remsen,
Chairman

April, 1915

Report of the Trustees of the Watson Fund

The will of the late James Craig Watson provided "for the promotion of astronomical science," but he expressed the wish that a medal should be given and that tables should be prepared of the motions of all the planets discovered by him. This last wish has now been carried out in a most satisfactory manner by Professor A. O. Leuschner, so that the income which has been used for this purpose during the last fourteen years is now available for the promotion of astronomical science in other directions.

The undersigned accordingly recommend the following votes:

Resolved, That the sum of five hundred dollars from the income of the Watson Fund be appropriated to Professor John A. Miller, director of the Sproul Observatory, for measuring plates already taken for the determination of stellar parallaxes.

Resolved, That the sum of three hundred dollars be appropriated from the income of the Watson Fund to Mr. John E. Mellish, to enable him to undertake observations at the Yerkes Observatory.

E. C. Pickering, *Chairman,*
W. L. Elkin,
Edwin B. Frost

April 2, 1915

Report of the Committee on the Henry Draper Fund

The committee unanimously recommends to the academy that the following grants for research be approved:

Five hundred dollars to Dr. W. W. Campbell, director of the Lick Observatory, for the purchase and construction of spectrographic and other apparatus for use with the Crossley Reflector.

Two hundred and fifty dollars to Dr. S. A. Mitchell, director of the Leander McCormick Observatory, for the purchase of a machine for measuring astronomical photographs.

George E. Hale,
Chairman

Report of the Committee on the J. Lawrence Smith Fund

TO THE NATIONAL ACADEMY OF SCIENCES:

In regard to researches now in progress or lately completed which have received aid from this fund the committee reports as follows:

Grant No. 3. Edmund Otis Hovey, curator in geology and paleontology in the American Museum of Natural History, New York, received in 1910 a grant of $400 in aid of the study of certain meteorites. Metallographic and chemical examinations are in progress. Dr. Hovey is at this time out of the country.

Grant No. 4. Professor C. C. Trowbridge, of the department of physics in Columbia University, received in 1910 a grant of $400 in aid of his study of the luminous trains of meteors. The academy has also made further grants of $250 in 1912, of $250 in 1913, and of $250 in 1914. The important work of collecting, verifying and tabulating records of observations of luminous trains has been diligently pursued. Lately, the collection and preparation for publication of drawings of luminous trains has been undertaken. In accordance with the vote of the academy in 1912, three payments have been made from this grant and it is expected that the fourth and last installment will be required during the current year.

Grant No. 5. Dr. George P. Merrill, curator in the department of geology in the United States National Museum, received a grant of $200 in 1910, and of $200 in 1911, to aid in the study of the occurrence of certain elements suspected to be present in small quantities in some meteorites. This work has been successfully completed, and the final report is ready for submission to the academy; the report contains a tabulation of all available trustworthy analyses of meteorites, and is accompanied by a special paper on the occurrence in meteorites of francolite or some allied phosphatic mineral in place of the apatite of terrestrial rocks.

The cash balance of income now available for grants is $874.87, and the invested income is $1,532.50.

EDWARD W. MORLEY,
Chairman

Professor S. A. Mitchell, University of Virginia, has applied for a grant of $500 to aid in the computation of orbits of meteors. Dr. Charles P. Olivier, president of the American Meteor Society, has computed orbits from some nine thousand observations of meteor paths, and has some thousand observations awaiting reduction. He has published two important papers containing several hundred computed orbits. The committee recommend the grant of $500 to Professor S. A. Mitchell, to aid in computations of orbits of meteors.

EDWARD W. MORLEY,
Chairman

The following motion was presented:

That the Committee on the J. Lawrence Smith Fund recommend that the meteorites remaining from the purchases by Dr. Merrill be deposited by the National Academy of Sciences in the United States National Museum.

Report of the Board of Directors of the Benjamin Apthorp Gould Fund

The income balance of the Gould Fund is now, in cash, four hundred and four dollars and sixty-four cents ($404.64); in readily negotiable securities, four thousand and fifty-seven dollars and fifty cents ($4,057.50), and in an unpaid grant to the *Astronomical Journal*, one thousand dollars ($1,000).

F. R. MOULTON,
E. E. BARNARD

Report of the Directors of the Wolcott Gibbs Fund

The trustees of the Wolcott Gibbs Fund for Chemical Research have the honor to present their annual report to the National Academy of Sciences. Since the last report three grants have been made from the income of the Fund as follows:

III. One hundred dollars to Professor W. J. Hale, Ann Arbor, to pay for assistance in a research on derivatives of 2.3-diacetylpentadiene, voted May 15, 1914.

Professor Hale reports that he has prepared the cyclopentadiopyridazine and the corresponding phenyl compound, and determined their composition. He hopes to finish the research before the summer vacation.

IV. Two hundred dollars to Professor W. D. Haskins, University of Chicago, for making a special potentiometer and galvanometer to study cobaltammines and ternary systems of fused salts. Voted November 25, 1914.

Professor Haskins reports that a beginning has been made on the work in spite of his severe sickness and the fact that the war has prevented him from obtaining part of the apparatus from Germany.

V. A second grant of one hundred dollars to Professor Mary E. Holmes, of Mount Holyoke College, for assistance in her work on the electrolytic determination of cadmium. Voted March 18, 1915.

Professor Holmes reports that she has purchased platinum electrodes of a new form, and with these has studied the deposition of cadmium and copper, so that she is now beginning to study the electrical separation of cadmium from other metals.

The unexpended income of the fund amounted on April first to $111.99.

C. L. JACKSON,
Chairman

Report of the Committee on Solar Research

The committee begs to call the attention of the academy to the publication of Vol. IV. of the *Transactions* of the International Union for Coöperation in Solar Research, which contains the complete proceedings of the last meeting in Bonn, reports of the various committees, resolutions adopted by the Union, and several scientific papers on solar and stellar phenomena.

The four volumes of *Transactions* already published by the Solar Union may be obtained from Messrs. Longmans, Green & Company, Fourth Avenue and 30th Street, New York, at $2.50 per volume.

George E. Hale,
Chairman

Recommendations from the Council

That the following bequest from Mrs. Mary Anna Palmer Draper be accepted.

Extract from the Will of Mrs. Mary Anna Palmer Draper, Page 7, Section 9 (*Second Paragraph*): "I give and bequeath to the National Academy of Sciences, Smithsonian Institution, Washington, D. C., the sum of twenty-five thousand dollars ($25,000)."

Report of the Editorial Board of the Proceedings

The editorial board of the *Proceedings* reports to the academy that four numbers of the *Proceedings* have now been issued, containing sixty-seven original papers in addition to the report of the autumn meeting, notices of scientific memoirs, and announcements. These numbers have consisted of 258 pages, an average of 64 pages per number and of about four pages per article. The papers are distributed among different sciences as follows: mathematics, 11; astronomy, 11; physics, none; chemistry, 11; geology, 2; paleontology, 1; botany, 4; zoology (including genetics), 12; physiology, 8; pathology, none; anthropology, 5; psychology, 2. It will be noticed that the subjects of physics, of geology and paleontology, and of pathology, have been very inadequately represented; and the editorial board urges members of the academy in these fields to endeavor to remedy this situation.

An edition of 3,000 copies of these four numbers has been printed. Of this edition about 900 are to be sent abroad to the libraries of universities and other active research institutions upon a mailing list prepared with great care by the foreign secretary aided by members of the editorial board. Of this edition 1,200 copies have also been distributed in this country by the home secretary to important libraries and to the thousand persons whose names are starred in Cattell's American Men of Science.

Arthur A. Noyes,
Chairman

Report of the Committee on the Collection of Historical Portraits, Manuscripts and Instruments

To the President and Members of the National Academy of Sciences:

Your committee on the collection of historical portraits, manuscripts and instruments, including instruments purchased at the expense of the trust funds which are no longer needed for the original purpose, begs to report as follows:

That the collection of portraits of the members of the academy has been brought together and arranged alphabetically.

That the foreign secretary has turned over the medal from the Groningen Academy celebrating its four hundredth anniversary.

That the following apparatus was presented by Mrs. Henry Draper and has been deposited in the United States National Museum:

1 slit.
1 spectrum photograph (broken).
1 liquid prism cell.
1 prism with 2-inch faces.
1 bundle—attempts of Henry Draper to rule gratings.
1 speculum metal ruled surface; 2-inch, square.
1 bunsen burner.
2 boxes, 12 photographs each.
1 box, 50 photographs.
1 box, 34 photographs.
1 box, 22 photographs.
1 box, 15 daguerreotypes.
1 box, 7 photographs.
13 Geisler tubes.

Election of Members of the Council

Mr. W. H. Howell and Mr. J. M. Coulter were chosen to succeed Mr. W. T. Councilman and Mr. R. S. Woodward.

Election of New Members

Henry Seely White, mathematician, Vassar College, Poughkeepsie, N. Y.

Charles Greeley Abbot, astrophysicist, Astrophysical Observatory, Smithsonian Institution, Washington, D. C.

Robert Andrews Millikan, physicist, University of Chicago, Chicago, Ill.

Alexander Smith, chemist, Columbia University, New York City.

Samuel Wendell Williston, paleontologist, University of Chicago, Chicago, Ill.

William Ernest Castle, zoologist, Harvard University, Cambridge, Mass.

Frank Rattray Lillie, zoologist, University of Chicago, Chicago, Ill.

Graham Lusk, physiologist, Cornell University Medical College, New York City.

Victor Clarence Vaughan, pathologist, University of Michigan, Ann Arbor, Michigan.

Granville Stanley Hall, psychologist, Clark University, Worcester, Mass.

An amendment to the constitution was adopted which permits the admission of 15 members annually in future.

ARTHUR L. DAY,
Home Secretary

NEW ORLEANS MEETING OF THE AMERICAN CHEMICAL SOCIETY

THE fiftieth meeting of the American Chemical Society was held in New Orleans, Louisiana, March 31 to April 3, 1915. For the most part, the members reached New Orleans during the morning of March 31 and spent some hours in viewing the unique attractions of the city. At 4:30 P.M., two hundred and fifty members and guests boarded a steamer for a trip down the Mississippi River, the usual complimentary smoker being held on the boat. The smoker was one of unusual attractions, the long cabin of the boat being festooned with Spanish moss and laurel and various southern evergreens, making a very attractive scene. The evening was enlivened by music from two orchestras and a vaudeville troupe. The boat returned to New Orleans in time for the council meeting, held at ten o'clock P.M. at the Hotel Grunewald. On Thursday morning, April 1, after addresses of welcome by Hon. Martin Behrman, mayor of New Orleans, and President Robert Sharp of Tulane University, and an appropriate response from President Charles H. Herty of the society, the general meeting was called to order. Professor Alfred Werner, of the University of Zurich, having been duly nominated and having received a majority vote of the council, was elected to honorary membership in the society. The meeting then listened to an address by A. D. Little on "The Industrial Resources and Opportunities of the South." Following this address, the Industrial Division held a public symposium throughout the day, presenting the following papers, all of which, with the exception of the paper by H. A. Huston, have been printed in the April, 1915, issue of the *Journal of Industrial and Engineering Chemistry*.

Contributions of the Chemist to the Wine Industry: Charles S. Ash, consulting chemist.

Contributions of the Chemist to the Copper Industry: J. B. F. Herreshoff, vice-president Nichols Copper Company and consulting engineer General Chemical Company.

Contributions of the Chemist to the Corn Products Industry: E. T. Bedford, president Corn Products Refining Company.

Contributions of the Chemist to the Asphalt Industry: James Lewis Rake, secretary The Barber Asphalt Paving Company.

Contributions of the Chemist to the Cotton-seed Oil Industry: David Wesson, manager of the Technical Department, Southern Cotton Oil Company.

Contributions of the Chemist to the Cement Industry: G. S. Brown, president Alpha Portland Cement Company.

Contributions of the Chemist to the Sugar Industry: W. D. Horne, consulting chemist.

Contributions of the Chemist to the Incandescent Gas Mantle Industry: Sidney Mason, president of the Welsbach Company.

Contributions of the Chemist to the Textile Industry: Franklin W. Hobbs, President Arlington Mills, and Past President American Cotton Manufacturers' Association.

Contributions of the Chemist to the Fertilizer Industry: H. Walker Wallace, Manager General Sales Department, Virginia-Carolina Chemical Company.

Contributions of the Chemist to the Soda Industry: F. R. Hazard, President of the Solvay Process Company.

Contributions of the Chemist to the Leather Industry: William H. Teas, President Marion Extract Company.

Contributions of the Chemist to the Flour Industry: John A. Wesener and George L. Teller, Consulting Chemists.

Contributions of the Chemist to the Brewing Industry: Gaston D. Thevenot, Consulting Chemist.

Contributions of the Chemist to the Preserved Foods Industry: R. I. Bentley, Vice-president and General Manager California Fruit Canners' Association.

Contributions of the Chemist to the Potable Water Industry: Wm. P. Mason, Professor of Chemistry, Rensselaer Polytechnic Institute.

Contributions of the Chemist to the Celluloid and Nitro-cellulose Industry: R. C. Schupphaus, Consulting Chemist.

Contributions of the Chemist to the Glass Industry: A. A. Houghton, Vice-President Corning Glass Works.

Contributions of the Chemist to the Pulp and Paper Industry: F. L. Moore, president American Paper and Pulp Association.

The Strassfurt Potash Industry: H. A. Huston.

A complimentary luncheon was served at the Tulane refectory, the university being host. On Thursday evening a public address to the people of New Orleans by Bernhard C. Hesse, entitled "The Chemists' Contribution to the Industrial Development of the United States—A Record of Achievement," was given at the Hotel Grunewald, a large attendance being present. On Friday divisional meetings were held, before which one hundred and fifty-three papers were presented. The details of these papers and a further description of the meetings will be found in the May issue of the *Journal of Industrial and Engineering Chemistry*. Friday evening a subscription dinner was held at the Restaurant de la Louisiane, which will long be remembered by those present for the charming company and the creole cuisine. On Saturday one hundred of the members took a special train to Weeks Island and visited the famous salt-mine of the Myles Salt Co. The train went through the bayou region of Louisiana, made famous by Longfellow's poem, "Evangeline." The newly planted sugar-fields and the swamps, with their Spanish moss and the early tropical herbage, were attractive to all. The mine, which is an unusual one, was entered by a shaft six hundred feet deep, the bottom of which opened into galleries cut in solid salt many hundred feet long and eighty-five feet high by eighty-five feet wide, entirely unsupported by timbers. The salt, approximately 99.9 per cent. pure, is simply blasted out, carried to the surface, screened to various sizes, and placed on the market. The party returned to New Orleans in time to catch the evening trains. Many ladies were present at the meeting and, under the charge of the committee of which Mrs. E. J. Northrup was chairman, received many attentions from the people of New Orleans.

The ladies were present at the smoker and at the banquet and took the salt-mine excursion and were given a special trip through the Vieux Carre and to the Newcomb Pottery, and they had a dinner of their own at one of the famous local restaurants. One hundred and seventy-five members and approximately one hundred and twenty-five guests were present, so that the meeting was a very successful one from the point of numbers, considering the distance of New Orleans from the chemical center of the country. Meetings of the following divisions were held, full programs of which will appear in the May issue of the *Journal of Industrial and Engineering Chemistry:*

Industrial Chemists and Chemical Engineers.—H. E. Howe, in the absence of the chairman, was in charge. The following committees were appointed:

Committee on Standard Specifications and Methods of Analysis: (Chairman not appointed), A. M. Comey, J. O. Handy, Robert Job, F. G. Stantial.

Committee on Non-ferrous Metals and Alloys, a subcommittee of the committee on standard specifications: Wm. Price, chairman, Allen Merrill, Geo. L. Heath, Gilbert Rigg, Bruno Woichiechewski.

Committee on Soap Products: Archibald Campbell, chairman, C. P. Long, J. R. Powell, Percy H. Walker.

Committee on Glycerine, a subcommittee of the Committee on Soap Products: A. C. Langmuir, chairman, W. H. Low, S. S. Emery, R. E. Devine, J. W. Loveland, A. M. Comey.

Committee on Naval Stores: J. E. Teeple, chairman (other members not yet selected).

Committee on Alum: W. M. Booth, chairman, Chas. P. Hoover, Wm. C. Carnell.

Committee on Platinum: W. F. Hillebrand, chairman, Percy H. Walker, H. T. Allen.

Physical and Inorganic Chemistry.—E. P. Schoch, in the absence of the chairman, was in charge.

Fertilizer Chemistry.—Chairman J. E. Breckenridge was in charge.

Agricultural and Food Chemistry.—Chairman Floyd W. Robison was in charge.

Organic Chemistry.—C. G. Derick, in the absence of the chairman, was in charge.

Pharmaceutical Chemistry.—Chairman F. R. Eldred was in charge.

Biological Chemistry.—Chairman C. L. Alsberg was in charge.

Water, Sewage and Sanitation.—The following officers were elected: Edward Bartow, chairman; E. B. Phelps, vice-chairman; H. P. Corson, secretary; executive committee—the officers and C. P. Hoover and E. H. S. Bailey.

Charles L. Parsons,
Secretary

THE AMERICAN MATHEMATICAL SOCIETY

The one hundred and seventy-seventh regular meeting of the society was held at Columbia University on Saturday, April 24, seventy-one mem-

bers being in attendance* at the two sessions. President E. W. Brown occupied the chair, being relieved by ex-presidents Osgood, Moore and White and Vice-president Veblen. The following were elected to membership in the society: Professor L. S. Hill, University of Montana; Miss G. I McCain, Indiana University; Mr. J. L. Riley, Rice Institute. Eleven applications for membership were received.

The invitation of Harvard University to hold the summer meeting and colloquium of the society at Harvard in 1916 was accepted. The annual meeting will be held in New York City in December. Committees were appointed to arrange for these meetings and to present a list of nominations for officers for 1916. Professor P. F. Smith was reelected a member of the editorial committee of the *Transactions.*

Reports of the committees were received regarding the movement against mathematics in the schools and the possible relations of the society to the field now covered by the *American Mathematical Monthly.* It was decided that in the former matter no action of the society was at present advisable. The relations of the society to the field covered by the *Monthly* were carefully considered and the sense of the Council was embodied in the following resolution: "It is deemed unwise for the American Mathematical Society to enter into the activities of the special field now covered by the *American Mathematical Monthly;* but the council desires to express its realization of the importance of the work in this field and its value to mathematical science, and to say that should an organization be formed to deal specifically with this work, the society would entertain toward such an organization only feelings of hearty goodwill and encouragement."

The following papers were read at this meeting:

C. J. de la Vallée-Poussin: "Démonstration simplifiée d'un théorème de Vitali sur le passage à la limite sous le signe d'intégration."

C. A. Fischer: "Minima of double integrals with respect to one-sided variations."

G. M. Green: "Nets of space curves."

R. L. Moore: "A set of axioms in terms of point, region and motion."

R. L. Moore: "On the categoricity of a set of postulates."

H. S. Vandiver: "A property of cyclotomic integers and its relation to Fermat's last theorem. Second paper."

J. F. Ritt: "The reduction of invariant equations."

E. B. Wilson: "Linear momentum, kinetic energy and angular momentum."

F. H. Safford: "An irrational transformation of the Weierstrass $\wp$-function curves."

Arnold Emch: "A certain class of functions connected with Fuchsian groups."

G. D. Birkhoff: "An elementary double inequality for the root of an algebraic equation having greatest absolute value."

H. S. White and Louise D. Cummings: "Groupless triad systems on 15 elements."

Edward Kasner: "Conformal geometry in the complex domain."

Edward Kasner: "Convergence proofs connected with equilong invariants."

E. V. Huntington: "Notes on the catenary, including the case of an extensible chain."

R. C. Strachan: "Note on the catenary."

J. E. Rowe: "A property of the osculant conic of the rational cubic."

J. E. Rowe: "The node of the rational cubic as a rational curve in lines."

Dr. F. W. Beal: "A congruence of circles."

H. F. Stecker: "Linear integral equations whose solutions have only a finite number of terms."

C. A. Epperson: "Note on Green's theorem."

L. J. Reed: "Some fundamental systems of formal modular invariants and covariants."

J. R. Kline: "Double elliptic geometry in terms of point and order."

Alexander Pell: "On the curves of constant torsion."

J. W. Young and F. M. Morgan: "The geometries associated with a certain system of Cremona groups."

T. H. Gronwall: "A functional equation in the kinetic theory of gases."

J. W. Alexander, II: "A theorem on conformal representation."

J. H. Weaver: "The Collection of Pappus."

A meeting of the society was held in Chicago on April 2–3. The summer meeting will be held at the University of California and Stanford University, August 3–5.

F. N. COLE,
Secretary

SOCIETIES AND ACADEMIES

THE UTAH ACADEMY OF SCIENCES

THE eighth annual convention of the Utah Academy of Sciences was held in the chemistry lecture room of the University of Utah. Three sessions were held: one at eight P.M., Friday, April 2, one at 10 A.M., Saturday, April 3, and the closing meeting at two P.M., the same day.

President Marcus E. Jones occupied the chair at all the sessions.

Professor Byron Cummings, U. U., Dr. W. E. Carroll, U. A. C. and Dr. Helen I. Mattill, U. U., were elected to fellowships, and Isaac Diehl (Robinson, Utah), H. J. Maughan, U. A. C., Miss Mary Morehead, U. U., James R. Smith (Heber City), and Chas. E. Mau, B. Y. U., to membership in the academy.

The officers for the ensuing year are as follows:

President—Dr. Harvey Fletcher, B. Y. U., Provo.

First Vice-president—Dr. Frank Harris, U. A. C., Logan.

Second Vice-president—Dr. L. L. Daines, B. Y. U., Logan.

Permanent Secretary-treasurer—A. O. Garrett, Salt Lake High School.

Councillors—Professor J. L. Gibson, U. U., W. D. Neal, Salt Lake City, Dr. W. E. Carroll, U. A. C., Logan.

A committee was appointed to make arrangements for publication of the proceedings of the academy.

The following papers and lectures were presented:

"The Rights and Duties of the Scientist," by Professor Marcus E. Jones.

"The Textile Fabrics of the Cliff Dwellers," by Professor Byron Cummings, U. U. (Illustrated by numerous specimens taken from cliff dwellings.)

"Controlling Grasshoppers," by Dr. E. D. Ball, U. A. C.

"Effect of Soil Alkali on Plant Growth," by Dr. Frank Harris, U. A. C.

"Some Unique Rusts," by A. O. Garrett, Salt Lake High School.

"Effect of the Amount of Protein Consumed upon the Digestion and Protein Metabolism in Lambs and upon the Composition of their Flesh and Blood," by Dr. W. E. Carroll, U. A. C.

"A Determination of Avogadro's Constant N," by Dr. Harvey Fletcher, B. Y. U.

"The Voice Tonascope," by Dr. Franklin O. Smith, U. U.

"The Origin of Higher Orders of Difference Tones: Experimental," by Dr. Joseph Peterson, U. U.

"The Hot Air Furnace—A Study of Combustion," by Dr. W. C. Ebaugh, U. U.

"Color Photography," by Dr. Chas. T. Vorhies, U. U., and Professor Marcus E. Jones. (Illustrated by lantern projections of numerous color photographs taken independently by Dr. Vorhies and Professor Jones in Big Cottonwood Canyon and other parts of Utah.)

A. O. Garrett,
Secretary

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

At the 482d meeting of the society, held February 2, 1915, Dr. C. L. G. Anderson read an obituary on Dr. A. F. A. King, who died in Washington, December 13, 1914. Born in England in 1841 and coming to Virginia in boyhood, he graduated in medicine, both at Washington and at Philadelphia. Soon after the Civil War he served as surgeon at the Lincoln Hospital. From 1870 until his death he held medical chairs in Washington and the University of Vermont and made many contributions to medical and scientific literature. Among his anthropological papers was one on "The Evolution of Marriage Ceremony and its Import."

At the 483d meeting of the society, held February 16, 1915, a paper was read by Mr. William H. Babcock on "The Races of Britain." Three native languages have been spoken in parts of Great Britain since the sixth century. They represent three waves of invasion by blond peoples. The dark admixture in Britain comes from an earlier population, a fairly advanced neolithic race, probably from southern Europe, which perhaps had absorbed paleolithic remnants found in the island. Reports were made on several recent scientific trips. Professor W. H. Holmes and Dr. Aleš Hrdlička installed exhibits in Indian ethnology and physical anthropology for the Panama-California Exposition. These are new and very important and will form parts of permanent museums. Dr. J. W. Fewkes proved prehistoric cultural interchanges between Mexico and our southwest in the ruins of the valleys of the Santa Cruz in Arizona and of the Mimbres in New Mexico. The former are of the Casa Grande type. More than 800 specimens were brought back, including 250 of painted pottery. Dr. Truman Michelson found scarcely a dozen of the 600 Stockbridges now in Wisconsin who remember a few Stockbridge words. The language was definitely placed in the Pequot-Mohegan and Natick division of central Algonquian dialects, although related to the Delaware-Munsee. Among the Brothertowns near Lake Winnebago, not one was found who remembered Brothertown words. Mr. J. N. B. Hewitt found on his trip to Canada only one survivor who remembered anything of the Nanticoke dialect. He also studied the place of song in the ceremonial of an Iroquois lodge.

Daniel Folkmar,
Secretary

SCIENCE

FRIDAY, MAY 14, 1915

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

CHARLES SEDGWICK MINOT[1]

I WISH to dwell in this paper not on the scientific attainments and successes of Charles Sedgwick Minot, but on the mental and moral qualities which his career illustrates and which made him what he was.

Young Minot did not follow the traditional course of education for the son of a well-to-do Boston lawyer. He did not go to Harvard College, but to the Massachusetts Institute of Technology and his first degree, that of bachelor of science, was obtained from that technical school. His major subject in that school was not the common one of engineering, but the uncommon one of natural history. He later pursued his studies in this unusual subject at Leipzig, Würzburg and Paris. Then, returning to Boston, he took the degree of doctor of science at Harvard University in 1878, again in the subject of natural history. His education, therefore, showed his determination in following his bent, and his independence in parting from his boyhood associates and his family's habitual practise in regard to the education of sons.

Then, as now, the only career open to students of natural history was a professorship in some branch of that subject, but this was not the career to which Minot looked forward. His studies were all histological and embryological, and their most practical and useful applications seemed to him to lie somewhere in the field of medical science and education.

Two years later he accepted two ap-

[1] Address before the Boston Society of Natural History at a memorial meeting held on March 17, 1915.

pointments in connection with Harvard University; one an appointment as lecturer in embryology in the medical school; the other an appointment as instructor in oral pathology and surgery in the dental school.

These appointments were procured for him with some difficulty, for he was not a doctor of medicine, and it was an unwelcome idea for the medical faculty that any instruction whatever should be given in the medical school by a person who had never taken the degree of doctor of medicine.

He accepted both these appointments with alacrity, although dentistry was not recognized then as a medical specialty, and immediately showed himself to be a competent lecturer and laboratory teacher in subjects which depended on the facile use of the microscope by both teacher and students. The place he took in the dental school had, just previously, been filled by Arthur Tracy Cabot, who had shown by his acceptance of that appointment his sympathy with the efforts of the university to lift and improve the dental school and the dental profession, and his prophetic belief that the relations between dentistry and clinical medicine were to become much more intimate than they had been.

In 1883, Minot was advanced to the position of instructor in histology and embryology, and this subject was given a satisfactory place in the curriculum of the medical school. There was still resistance to the appointment of a teacher who did not hold the degree of doctor of medicine, but Minot had, in three years, proved not only that he was the vigorous teacher, but that he had business qualities which would make him a remarkably good director of a laboratory for the instruction of medical students. He devised an excellent method of buying microscopes for the whole class and loaning them to students for a term fee which was sufficient to keep every microscope in repair and in time to repay their whole cost.

He studied every detail of the furniture and fittings of a medical laboratory and decided on the shape and the size of the desk room which each student needed. He made highly intelligent use of the card catalogue for his growing collection of embryological specimens, for his library and for his student records. He became expert in everything relating to the conduct of a laboratory and set a good example to all the other teachers who were conducting laboratories in the medical school. As the school was then in the process of changing from a school in which the lecture predominated to a school in which the laboratory predominated, Minot became more and more useful to the medical school as a whole.

In the year 1887, it was possible to appoint him to an assistant professorship of histology and embryology. At the expiration of the usual term for an assistant professor (five years) he was made professor of histology and human embryology, and in this appointment, with its new title. Minot's special subjects and his high merits both in teaching and in research were fully recognized.

Between 1881 and 1883, the medical faculty planned and erected a new building for its own use on Boylston Street, at the corner of Exeter Street—a building in which laboratories occupied a large part. Minot obtained for his courses an excellent laboratory of his own planning. There, in twenty years, he built up his unique embryological collection; a monument to his insight, skill, industry and power of inspiring others with his own zeal. In less than twenty years this building became inadequate for the best development of the medical school, and the new buildings of 1905 began to be planned. The fundamental consideration in planning and constructing the new buildings was to adapt them thoroughly to the new method of instruction in

medicine—a method which relied chiefly on individual instruction and laboratory work. Minot's careful study of the best laboratory conditions for small sections, in well-lighted and well-ventilated rooms, with a desk for each student, was taken up again and contributed much to the final success of the architect's plans. The accommodations for the department of histology and human embryology conformed to Minot's conception of the present and future needs of his department and served as a type for the laboratories of other departments in the school.

It became possible to enlarge the number of teachers employed in the department, and its intimate connection with the teaching of anatomy was recognized. When Dr. Thomas Dwight, professor of anatomy since 1883, died in 1911, the school was fully prepared to recognize the fact that anatomy and histology belonged together. In the mean time, the James Stillman professorship of comparative anatomy had been endowed and to that Professor Minot had been transferred in 1905. No professor of anatomy was appointed to succeed Dr. Dwight, but in 1912 Minot was made director of the anatomical laboratories in the Harvard Medical School. This action of the faculty and the corporation crowned Minot's professional career as a student and teacher of natural history, applied in medical education. By clear merit he had made his way and the way of his department in the school and without a medical degree had become the head of anatomical teaching in a medical school. Under him in the anatomical department were two assistant professors, one of whom was called assistant professor of anatomy and the other of histology. Fourteen other teachers were employed in the department of anatomy and histology, three of whom bore the title of histology and embryology, Minot's original subjects in the medical school.

Minot's advance through the medical school was not facilitated by a yielding or compromising disposition, or any practise of that sort on his part. On the contrary, he pursued his ends with clear-sighted intensity and indomitable persistence; suavity and geniality were not his leading characteristics in discussion or competition and he often found it hard to see that his opponent had some reason on his side. Like most independent and resolute thinkers, he had confidence in the soundness of his own reasoning, and in the justice of the cause or movement he had espoused.

He was upright in every sense of that word. His loyalty was firm and undeviating, whether to an ideal or a person or an institution, and affection and devotion, once planted in his breast, held for good and all.

His book on "Human Embryology" published in 1892 made him famous throughout the learned world, so that he was elected to learned societies in Great Britain, Italy, France, Germany and Belgium; as well as to all appropriate American societies. He also received honorary degrees from the universities of St. Andrew's (Scotland), Oxford (England), Toronto (Canada), and Yale. He enjoyed calmly and simply the honors thus paid to his scientific attainments and services by well informed and impartial judges.

In 1913 he was Harvard exchange professor at the universities of Berlin and Vienna, where he gladly availed himself of many opportunities to expound to his German colleagues the advances in natural history, including medicine, which were due to American investigators.

His hair and beard were now whitening, but he felt all the ardors of youth, and among them, fervid patriotism. In scientific investigation Minot showed imagination, penetration and eagerness, but also caution. In 1907 he gave a course of lectures at the Lowell Institute on "Age,

Growth and Death" and made them the basis of a book published the following year. For him, the subject meant cell metamorphosis, with which he had been familiar through all his studies in histology and embryology, but what he sought in this subject of "Age, Growth and Death" was a scientific solution of the problem of old age which should have—I quote his words—"in our minds, the character of a safe, sound and trustworthy biological conclusion." He ventured to think that some contemporary students of the phenomena of longevity had failed to exercise sufficient caution in forming their conclusions. Nevertheless, Minot was a scientific optimist; full of hope for perpetual progress and for useful results at many stages of the long way. These characteristics appeared clearly in the following passage, taken from the first lecture of that course at the Lowell Institute:

> I hope before I finish to convince you that we are already able to establish certain significant generalizations as to what is essential in the change from youth to old age, and that in consequence of these generalizations now possible to us new problems present themselves to our minds, which we hope really to be able to solve, and that in the solving of them we shall gain a sort of knowledge which is likely to be not only highly interesting to the scientific biologist, but also to prove in the end of great practical value.

There spoke the cautious, modest, hopeful scientist, expectant of good. Such is the faith which inspires the devoted lives of scientific inquirers.

CHARLES W. ELIOT

THE STIMULATION OF GROWTH[1]

I

THE growth of living organisms differs from that of crystals in three essential features. While the crystal grows only in a supersaturated solution of its own substance, living organisms can grow indefinitely in even a very low concentration of their nutritive solution; second, the nutritive solution need not and perhaps should not contain the compounds found in the cells, but only their split products, while in the case of the crystal the substance of crystal and solute must be identical. And thirdly, growth leads in living cells to the process of cell division as soon as the mass of the cell reaches a certain limit. Needless to say this process of cell division can not even metaphorically be claimed to exist in a crystal.

The fact that the cell can grow in a very low concentration of its nutritive solution, and the further fact that the nutritive solution only needs to contain the building stones for the complicated compounds of the cell, find their explanation in the assumption of the existence of synthetic enzymes or synthetic mechanisms in the cell.

The problem of growth is linked with that of death and immortality, since it would follow from our definition that the growth of a cell should go on eternally in a proper nutritive solution and under suitable conditions of temperature, provided that the synthetic catalyzers last and that they synthetize their own substance.[2] This is apparently true for bacteria and perhaps also for protozoa. Weismann has claimed immortality for all unicellular organisms and for the sex cells of metazoa, while he concedes mortality to the body cells. Leo Loeb recognized that immortality may be claimed also for the cells of malignant tumors, like cancer, for he had found that when he transplanted cancer cells on other animals the cells of the original cancer and

[1] Read at the meeting of the National Academy in Washington, April 19, 1915.

[2] This latter assumption leads to the connection of the problem of growth with that of autocatalysis as suggested first by the writer in 1906 and worked out subsequently in the papers of Wo. Ostwald and T. B. Robertson.

not the cells of the host grow into a new cancer. He suggested in 1901 that this claim might be extended to somatic cells in general.

The idea suggests itself that not only the germ cells can be immortal, but that perhaps also the somatic cells, like connective tissue cells, might, under certain conditions, live for a long period, much longer than the individual life of the organism of which they were a part, that they might perhaps also be immortal in the same sense as the ovum is.[3]

Returning to the same problem in 1907 he added the following remarks:

There exists another very striking phenomenon in the growth of malignant tumors, to which I called attention in my first communications on the transplantation of tumors, namely the fact that tumor cells have apparently an unlimited existence and that they seem to resemble in this respect the germ cells. It is certain that their life and growth exceeds that of the other somatic cells of the individual, from which they are taken. But at present we are not yet justified in saying that the tumor cells differ in this specifically from certain other somatic cells. It has been tacitly assumed thus far that the somatic cells of the metazoa have only a limited existence, but no attempt has been made to determine exactly the possible duration of life of somatic cells. We must therefore consider the possibility that certain somatic cells possess the same apparently unlimited duration of life as somatic tumor cells. . . . This seems to be a biological problem of great bearing to which the experimental investigation of tumors has led, and it might be possible to decide experimentally whether or not other cells resemble tumor cells in this respect.[4]

The experimental decision seems to have been furnished, since Carrel has succeeded in keeping connective tissue cells from a chick embryo alive for over three years, and these cells are still growing and dividing. It should be added, however, that similar attempts with other cells have not yet met with the same success.

[3] Leo Loeb, "On Transplantation of Tumors," *Jour. Med. Res.*, VI., 28, 1901.

[4] Leo Loeb, "Beiträge zur Analyse des Gewebewachstums," *Arch. f. Entwicklungsmech.*, XXIV., 655, 1907.

While thus theory and experience seem to agree to some extent, a closer examination of actual conditions reveals a somewhat different and more complicated situation. The egg cell, for which Weismann claimed immortality, can not grow and develop and will die quickly if it is not fertilized at a certain stage of its existence. The cells in the body will not grow constantly as our definition seems to demand, but their growth is followed by a period of rest from which they may be aroused by special substances or by a wound. Moreover, all differentiation of form in animals and plants depends on the fact that the different parts grow with different velocities, since otherwise all organisms would be perfect spheres.

In reality then the resting condition of a cell seems to be as much a part of real life as growth and cell division. Yet the definition from which we started is apparently correct, and it may be that we have to define the additional conditions which make a resting cell possible and which will wake a resting cell from its slumber.

II

In the usual treatment of the problem of growth the increase of mass of the whole organism is taken into consideration. While this method is adequate for the study of the relation of nutrition to growth, it is not adequate for the study of the stimulation of growth. In the latter case we must remember that it is the individual cell which grows, and that we must therefore study the mechanism of this stimulation in the individual cell and not in the organism as a whole. The ideal object for this study is the egg cell, since we can observe it in the condition of rest as well as of cell division and growth.

Since usually cell division follows growth and is possibly a consequence of the increase of mass of the cell, this rule does not

always hold in the egg cell, where as a rule immediately after fertilization a series of cell divisions follow without any increase of mass of the egg. The egg, when divided into two or more cells, does, as a rule, not weigh more (and may possibly weigh a little less) than the original egg cell before it began to divide. This exception from the rule that cell division is preceded by growth of the cell is not real, since the egg cell is at first much larger than the ordinary body cell of the growing organism. If the relation between size of cell and cell division exists we must expect that the egg cell after it is fertilized must first undergo a series of cell divisions without any growth, until each cell of the original egg has been reduced to the size of the cell characteristic for the species. Only after this has happened can the ordinary cycle of growth of the cell with subsequent cell division begin.

The writer is suspicious that even in eggs where we notice at first cell division without growth, in reality growth may take place. Such eggs as those of the sea urchin consist largely of reserve material which is gradually transformed into the peculiar state which we designate as living protoplasm (and which may differ from non-protoplasmic material in the possession of synthesizing enzymes or mechanisms). In the first stages of cell division this transformation of reserve material into living material may occur, and this transformation is the real growth which we observe in the bacteria and later on in the cells of metazoa, but which is not directly visible in the first stages of cell division in the egg.

The unfertilized egg immediately before fertilization is usually unable to divide even under the most perfect conditions. With all the food existing in a hen's egg the germ can not grow unless it is fertilized, while this growth takes place after a spermatozoon has entered the egg. There exists, therefore, a mechanism by which the same egg cell can be in a state of rest in which growth is inhibited. What is the nature of this peculiar inhibitory mechanism and what is the mechanism by which the entrance of a spermatozoon abolishes this inhibition? The experiments on artificial parthenogenesis[5] allow us to give a partial answer to this question.

In the case of certain eggs, *e. g.*, the egg of the sea urchin, the entrance of a spermatozoon is followed immediately by a striking change in the surface of the egg. The latter surrounds itself with the so-called fertilization membrane. If we induce this membrane formation by certain chemicals (*e. g.*, a short treatment with a fatty acid) the eggs when put back into normal sea water will begin to develop at a low temperature and may reach the larval stage. But at the temperature of the room or even of the ocean the eggs may begin to develop, but they will perish the more rapidly the higher the temperature. On the other hand, the eggs if fertilized with sperm will develop at room temperature. What causes this difference? The answer is that the alteration of the surface of the egg induced by a fatty acid initiates development but is not sufficient to guarantee a normal development at ordinary conditions. For this purpose a second treatment is required and this can be given in the form of a short treatment with a hypertonic solution or a longer treatment with lack of oxygen. After the egg has received the second treatment it can develop into a normal larva at room temperature. I am suspicious that even a third factor may have to be supplied, since the mortality of the parthenogenetic larvæ is greater than that of the normally fertilized eggs.

Why is it that the membrane formation, or more correctly an alteration of the sur-

[5] The reader is referred to the writer's book on "Artificial Parthenogenesis and Fertilization," Chicago, 1913, for details and literature.

face layer of the egg, which may or may not result in a membrane formation, starts the development of the egg? The writer had found that the fertilized egg can not develop if deprived of oxygen, but that development begins again instantly if oxygen is admitted. From this and other observations he concluded that fertilization by sperm as well as artificial membrane formation induced development by raising the rate of the oxidations in the egg, and this surmise was confirmed by actual measurements by O. Warburg as well as by Wasteneys and the writer.[6] It was found that the entrance of a spermatozoon into the egg raises the rate of oxidations from 400 per cent. (*Arbacia*) to 600 per cent (*Strongylocentrotus purpuratus*) and that artificial membrane formation by butyric acid raises the rate of oxidations to exactly the same amount.

The changes which determine this characteristic rise in the rate of oxidations of the egg are situated at the surface of the egg, in its cortical layer. The process underlying membrane formation can be called forth by any substance which causes cytolysis—that form of destruction of the cell which results in the transformation of a cell into a mere shadowy skeleton. Any cytolytic agent will induce membrane formation and also development in the unfertilized egg, if it is allowed to act on the superficial layer of the egg only, *i. e.*, if the egg is removed from its influence after the membrane formation. If it is not removed the whole egg will undergo cytolysis and can no longer develop. But such eggs will still show the rise in the rate of oxidations which follows artificial membrane formation, thus indicating that the sudden rise in the rate of oxidations which we notice after artificial membrane formation depends only upon the alteration of the surface of the egg, regardless of the condition of the rest of the egg.

[6] There are indications that other processes are also initiated or accelerated by fertilization, but this may be omitted from consideration in this connection.

The forces which induce the egg cell to develop are, therefore, localized at the surface of the cell and consist in a change (possibly a cytolysis) of the cortical layer of the egg. We do not know how this change induces the rise in the rate of oxidations upon which development depends, but from Warburg's work it appears probable that the oxidations in the sea urchin egg are due to a catalysis by iron. This would indicate the possibility that in the cytolysis of the cortical layer of the egg the iron would be transformed from a condition where it is unable to act as a catalyzer into a condition where it can act in this capacity.

We have mentioned the fact that all cytolytic agencies call forth the membrane formation in the unfertilized egg. Such cytolytic substances (the lysins of the bacteriologist) are also contained in the blood and cell extract of each animal; only with this limitation that the cells of our own body are immune against the action of our own lysins, but not against the lysins in the blood and cell extract of other animals. I was able to show that we can call forth membrane formation and development in the sea urchin egg with foreign blood, *e. g.*, ox blood, or with the extracts of foreign tissues, but not with their own blood or tissue extract. Wasteneys and the writer could show later that this method can be applied generally for artificial parthenogenesis. This immunity of the egg towards the lysins of its own body we may explain on the assumption that the lysins contained in foreign blood can enter the cell, while the latter is impermeable for the lysins contained in the blood or tissue extract of the same species. If it were not for this immunity, all the eggs would be induced to

develop before they leave the ovary. This is not the case.

The work on physiologically balanced salt solutions has brought out the fact that the permeability of the cells in a body may undergo variations and when this happens it is conceivable that the lysins in the blood may induce eggs to develop in the ovary. Leo Loeb states that 10 per cent. of the eggs in the ovary of a guinea-pig may show a beginning of parthenogenetic development, and certain spontaneous tumor formations in the human ovary may find their explanation in this way. In other words, it is not excluded that one form of limited growth may be due to the immunity or impermeability of cells to blood of the same species.

The question then why an unfertilized egg can not grow and why a fertilized egg possesses the power of dividing and growing is therefore answered in the sense that both conditions depend apparently upon the condition of the surface layer of the cell.

The most important fact for our present problem is the observation that the alteration which starts the development of the egg is to some extent reversible. The history of the egg is such that after a number of cell divisions the final stage of the unfertilized egg ready for fertilization is reached. If at that stage it is fertilized by sperm or induced to develop by artificial means the processes of cell division and growth will continue; if not, the egg will soon die. There is a third possibility. The unfertilized egg may start to develop, then stop and go practically, though not entirely, back into the state in which it was before starting to develop.

The clearest case of this kind was observed in the egg of the Californian sea urchin. When the unfertilized egg of *Strongylocentrotus purpuratus* is treated with a hypertonic solution the eggs may begin to segment into two, four, or eight or sixteen cells, but then they cease developing and go back into the resting condition in which they were before the egg started dividing, with the exception of one condition which will be mentioned later. In the place of each of the original eggs we have now two, four, eight, etc., smaller cells. The observation is of importance for the theory of fertilization, because it disposes of the idea once held by Boveri that eggs are in the resting stage because they are lacking the apparatus for cell division; these eggs went into the resting stage again in spite of the fact that they possessed the apparatus for normal cell division. If the cells of such an egg are at a later time fertilized with sperm, they form a fertilization membrane and develop. They will develop also into larvæ if they only receive the butyric-acid treatment without the corrective factor. The original treatment with the hypertonic solution provided these eggs permanently with the corrective effect.

What caused these eggs which were segmenting to go back into the resting stage? I am inclined to assume that in these eggs the change in the cortical layer which started the development was gradually or suddenly reversed. We should expect this to betray itself in a lowering of the rate of oxidations. Wasteneys and I have found indeed that unfertilized eggs of *purpuratus*, which show an increase in the rate of oxidations after a treatment with a hypertonic solution, show a lower rate if examined after some time. It seems then possible that the change in the cortical layer which leads to a rise in the rate of oxidations is under certain conditions reversible.

These are not the only cases of reversion. I noticed that if the development of the eggs of *Arbacia* is induced either by a

treatment with butyric acid or by alkali, and if the eggs are afterwards prevented from developing (by putting them for a certain length of time into sea water containing NaCN) they will go back into a resting condition from which they can be aroused again by a treatment with sperm. We suspect that in this case the reversion in development is also accompanied by a reversion in the rate of oxidations.

We see then that our definition of a cell as being constantly ready to grow and segment is not strictly fulfilled even in the case of the egg cell, which, according to Weismann, we may consider as immortal. Instead we see that the egg cell can apparently alternate between a resting condition and an active condition, and that the nature of the cortical layer of the egg determines in which of the two conditions the egg exists.

From this we might conclude that our original definition, that each cell will grow and multiply eternally, may hold after all if we add the fact, that in the egg cell a variation in the nature of the cortical layer may start or inhibit cell division and growth. We may next ask: Does this addition also satisfy the facts we find in the adult body where the cells come to rest unless they are called into active growth again by a wound or by the not definitely known causes of tumor formation? Or, in other words: Is it only a change in the cortical layer which condemns the cells of the adult body to rest and those of the young body to grow?

Unfortunately, our task is not so easy. The unfertilized egg which is ready for fertilization will die comparatively rapidly, unless it is fertilized by sperm or treated by the methods of artificial parthenogenesis. We can prolong its life by suppressing its oxidations. Before the egg is mature its duration of life seems longer. If the eggs of the starfish are allowed to mature they die in a few hours if not fertilized; if they are prevented from becoming mature they live much longer. It is not known that anything similar to this exists in the somatic cells of the adult animal. Until such knowledge is acquired we must be prepared to admit that the resting cell of an adult organism is in a condition which is not comparable to that of the unfertilized egg.

III

We know that the growth of resting cells in a body may be induced if the blood contains certain substances which differ for different kinds of cells. One of the most recent and most striking observations in this direction was that of Gudernatsch, who found that in the tadpole of a frog or a toad, whose legs usually do not begin to grow until it is several months old, the legs can be induced to grow out at any time, even in very young specimens, by feeding them with the substance from thyroid glands. No other material seems to have such an effect. The thyroid contains iodine, and Morse states that if instead of the gland iodized amino-acids are fed the same result can be produced. We must draw the conclusion that the normal outgrowth of legs in a tadpole is also due to the presence in the body of substances similar to the thyroid in their action (it may possibly be thyroid substance) which is either formed in the body or taken up with the food.

That the phenomena of larval metamorphosis are independent of the influence of the central nervous system has been amply demonstrated. Thus I could show in 1896 that if we cut through the spinal cord of an amblystoma larva the metamorphosis of the body in front and behind the cut takes place simultaneously. Uhlen-

huth showed that if the eye of a salamander larva is transplanted into another larva the transplanted eye undergoes its metamorphosis into the typical eye of the adult form simultaneously with the normal eyes of the individual into which it was transplanted. These and other observations of a similar character show that substances circulating in the blood are responsible for the phenomena of growth in this case.

A very instructive observation on the rôle of internal secretion on growth was made by Leo Loeb. When the fertilized ovum comes in contact with the wall of the uterus it calls forth a growth there, namely, the formation of the maternal placenta (decidua). Leo Loeb showed that the corpus luteum of the ovary gives off a substance to the blood which alters the tissues in the uterus in such a way that any contact with any foreign body induces this deciduoma formation. The case is of interest since it indicates that the substance given off by the corpus luteum does not induce growth directly, but that it allows mechanical contact with a foreign body to induce growth, while without the intervention of the corpus luteum substance no such effect of the mechanical stimulus would be observable. The action of the substance of the corpus luteum is independent of the nervous system, since in a uterus which has been cut out and retransplanted into the animal the same phenomenon can be observed.

All these cases agree in this, that apparently specific substances induce or favor growth not in the whole body, but in special parts of the body. This recalls the idea of Sachs that there must be in each organism as many specific organ-forming substances as there are organs in the body. When this statement was made by Sachs the facts on the specific effect of internal secretion were unknown. To-day we can say that Sachs's theory is certainly supported by a stately array of facts.

There may also be substances which affect growth more generally. This is indicated in the apparent connection of acromegaly and giantism with diseases of the hypophysis and in the inhibition of longitudinal growth after extirpation of the thyroid.

We are, however, unable to answer the question as to how these substances induce the cells to grow. Are the resting cells in the body in the condition of the unfertilized egg and does the thyroid in Gudernatsch's experiment produce an alteration of the cortical layer of the cells from which the legs grow out, similar to that caused by the butyric-acid treatment of the egg? It would not be safe to make such an assumption at present, since we do not even know whether the products of internal secretion act directly on the growing cell or only in some indirect way. We only know that conditions of rest in the cells may be interrupted by the production of certain substances in the body or by their introduction in the form of food; and conversely we may suspect that the rest of the cells may have been enforced by the presence of other substances (or cells) in the blood antagonistic to the former.

The idea that the products of internal secretion or certain substances taken up in the food do not act directly upon the cells whose growth they influence, but indirectly through an alteration of metabolism, is strongly supported by the interesting observations of Geoffrey Smith. Claude Bernard and Vitzou had shown that the period of growth and moulting of the higher Crustacea is accompanied by a heaping up of glycogen in the liver and subdermal connective tissue. Smith found that during the period between two moultings when there was no growth the storage cells are seen to be filled with large and numerous

fat globules instead of with glycogen. He also found that in the *Cladocera* "the period of active growth is accompanied by glycogen—as opposed to fat—metabolism." He observed, moreover, that if *Cladocera* are crowded at a low temperature the fat metabolism (with inhibition to growth) is favored, while at high temperatures and with no crowding of individuals the glycogen metabolism is favored. In the latter case a purely parthenogenetic mode of propagation is observed, while in the former sexual reproduction takes place. The effect of crowding of individuals is apparently due to products of excretion, which then act on growth and reproduction indirectly by modifying the "glycogen metabolism" to "fat metabolism."

IV

Factors which directly inhibit growth have been discovered by Jas. B. Murphy, of the Rockefeller Institute. It was known that tissues can not be successfully transplanted into a different species. Murphy discovered that this rule does not hold for the chick embryo. Any kind of tissue, even human, will grow if transplanted to such an embryo. This growth of the transplanted tissue will stop, however, when the chick is ready to hatch, and Murphy found that this is due to the development of a certain type of cells in the chick embryo at that period, namely, the lymphocytes. Murphy found, moreover, that he could put adult mice and rats also into the condition of tolerance to foreign tissues when he destroyed their lymphocytes by an exposure to X-rays. As soon as the lymphocytes are formed again foreign tissues can not grow any longer on the animal. In this case we have a definite inhibition of growth by the action of lymphocytes which collect around the transplanted piece. It is not yet possible to state to what extent this observation on the inhibition of growth can be generalized.

We shall see later that possibly the opposite may also be true, namely, that certain cellular elements may have an accelerating effect on growth.

V

When a wound is made, cells which had been at rest may begin to grow. In many lower animal organisms and in plants whole organs may be induced to grow as a consequence of a mutilation. These phenomena are known under the name of regeneration. The name indicates the power of a living organism of restoring lost parts.

We can see from a physicochemical viewpoint why a cell should be endowed with a power of growing indefinitely, since we only need to assume the presence of suitable synthetic enzymes in the cell; but we fail to see from the same viewpoint why an organism should have the power of restoring lost parts. Weismann and others have tried to account for this power in a metaphysical way which was shown to be in conflict with the facts.

The statement that regeneration consists in the restoration of lost parts is not always the exact expression of the actual facts. In plants, *e. g.*, we notice—in the majority of cases—not a restoration of the lost parts but the outgrowth of one or more dormant buds which are often at some distance from the seat of injury. There has been some discussion whether in view of this fact we can say that regeneration exists in plants. This merely verbal difficulty disappears if we disregard the metaphysical sense of the term regeneration and realize that the essential feature of the phenomenon is the fact that if we wound living organisms, cells or anlagen which had ceased to grow suddenly begin to grow. Thus the problem of regeneration becomes a problem of

growth and the real question is: How can the process of wounding induce growth in cells which had been at rest and would probably have remained so during the whole term of life of the individual? It is not the wound in itself which induces the growth; since in plants the growth of new organs does as a rule not occur along the area of the wound, but at some distance where an old bud existed or a new one is formed. The distance of the growing or regenerating part from the wound may be quite considerable.[7]

It has been stated that the isolation of the parts is the cause of the new growth following the wound. Thus if a leaf of the tropical plant *Bryophyllum calycinum* is cut off from the plant each of the notches will give rise to a new plant when the leaf is kept in a moist atmosphere. (This is the regular way of propagating this plant.) But no such growth will occur as long as the leaf is kept in connection with the plant (and the latter is normal). Here we seem to have a clear proof of the generally accepted statement that isolation of parts leads to regeneration. The idea seems to be still further corroborated if we cut off a leaf with a piece of the main stem of the plant and suspend it in moist air. In this case no new plants will grow from the notches of the leaf. This again seemingly supports the idea that the separation of the part from the whole is the cause of growth since the leaf attached to a piece of the stem is less isolated than a leaf without any stem. Yet it can be shown that if we diminish the degree of isolation of the leaf still more by leaving it attached to a stem still possessing the opposite leaf the power of the first leaf to form new plants in its notches is enhanced again. The experiment can be made in the following way. From the same plant let be taken (1) an isolated leaf, (2) a leaf with a piece of stem, (3) a leaf with a piece of stem and the opposite leaf; let all leaves be suspended in a moist chamber with their tips submersed in water. The first and third specimen will form new plants in the submerged parts of their leaves in a comparatively short time, while the second will do so not at all or considerably later than the others.[8] Hence the experiment shows first that complete isolation induces the leaf to form new plants, that less isolation will inhibit this phenomenon, and that still less isolation will again call forth the regeneration. It is therefore plainly impossible to state that isolation is the cause of regeneration.

Those who make such a statement usually assume the existence of inhibiting influences in the plant and explain the effect of isolation on regeneration or growth on the assumption that the isolation frees the part from this inhibiting influence of the whole organism. We should be forced to assume that in the normal *Bryophyllum* there exists an inhibiting influence which prevents the buds in the notches of the leaves from growing, while when the leaf is cut off the notches are released from this inhibiting influence. To this idea we can agree, but then the question arises: What is this inhibiting influence? Thus it is a common experience that in the isolated stem of *Bryophyllum* only the apical buds will grow, while if we cut off the apical buds the next lower buds will grow out, and so on. Hence the growth of the apical buds inhibits the growth of the lower buds. Some more recent authors have suggested that a kind of nervous influence is responsible for this inhibition. But we have already mentioned a number of facts which show

[7] The process of healing, *i. e.*, of the closing of the wound, should be kept distinct from the phenomena of growth which constitute regeneration.

[8] A full account of these experiments on *Bryophyllum* will be published in the near future.

that in animals substances circulating in the blood influence growth independently of the central nervous system. In *Bryophyllum* I have recently made some experiments which seem to agree with this humoral theory of the control of growth. It can be shown in *Bryophyllum* that if a part *a* inhibits the growth in a part *b*, the presence of *b* favors growth in *a*.

We will illustrate this by two experiments. When we suspend in the moist air of a closed vessel a stem of *Bryophyllum*, whose tip, roots and leaves have been removed, only the buds in the uppermost node will grow into shoots. The growth of the apical shoots inhibits the growth of the lower buds. But if we isolate a node near the apex and suspend it in the same moist chamber, as a rule no regeneration will occur in this node; only if we leave the lower parts of the stem connected with the apical node can the latter regenerate in moist air. Hence the lower part *b*, in which regeneration is suppressed by the topmost part *a*, is necessary or helpful for the regeneration of the top *a*.

The same effect can be produced if, instead of leaving the node near the apex in connection with the lower pieces of the stem, we leave it in connection with one leaf or part of one leaf. In this case also growth of the bud will occur in the moist air. As we have already stated, the leaf is inhibited from forming new shoots in its notches through the connection with the stem. Hence the stem which inhibits the growth of shoots in the leaves is helped by the leaf in its own regeneration.

This seems to agree at first sight with the idea first suggested by Sachs that the specific shoot-forming substances do not exist in sufficient quantity in the topmost part of the stem and that they must be supplied to this piece either by a leaf or by a larger piece of stem. And on the same principle might be explained the inhibition of the top piece upon the regeneration of the lower nodes. To this assumption the simple objection is possible that a long stem contains material enough to form a dozen shoots or more, as can be shown if the stem is cut into shorter pieces. Each of the lower nodes will in this case form two new shoots. Yet the formation of two shoots at the apical node will prevent the formation of shoots at the lower nodes, although there is enough material to form shoots in every node.

It can be shown that the upper nodes if isolated will promptly form shoots if put into a thin layer of water. Hence the presence of a leaf or of the greater part of a stem enables the upper node to form shoots in moist air either by supplying it with the necessary amount of water or by establishing a flow of material. Where we have a closed circulatory system as in animals we know that the heart action can only maintain a circulation if the blood vessels are filled with blood. The writer is not sufficiently familiar with the circulation in plants, but botanists do not assume the existence of a closed circulatory system. But, however this may be, the presence of a sufficient quantity of water seems to be the prerequisite for a constant flow of substances in the conducting vessels. If we assume that the anatomy of the conducting vessels determines a flow of substances to the apex and second that the buds in that region hold *all* or practically all the formative or specific material which induces growth, the inhibition of growth in the lower buds becomes clear.

Hence we are inclined to explain both the inhibiting effect of an organ *a* upon the regeneration in *b* as well as the accelerating effect of *b* upon *a*, from the following three factors: first, the peculiarities of the anatomy of the conducting vessels in the plant;

second, the necessity of a flow for the transport of substances inducing growth; and third, the retention of these substances (even beyond need) by or near the organs which are first induced to grow or regenerate.

Such a view is supported by the older experiments of the writer on *Tubularia*. *Tubularia* is a hydroid consisting of a hollow stem attached with stolons to a solid substrate, usually piles or rocks, and bearing at its free end a polyp. Only the region behind the hydrant and the tips of the stolons show growth, the cells in the stem do not grow any more. We can, however, induce the cells in any cross section of the stem to grow into a polyp if we cut off the rest of the stem above or beneath it. How does this operation induce growth? The first idea might be that this is due to the wound; the wound, however, can only be the indirect cause, since we perceive such an outgrowth of polyps also from the tips of the uninjured stolons.

I observed that when we cut a piece *ab* from the stem and if we suspend it in sea water, both ends *a* and *b* form polyps, but that the oral end forms its polyps considerably more quickly than the aboral end; and the difference in time may be from one or two weeks to one or two days, according to the temperature and the species used for the experiment. We may, however, induce the aboral end to form its polyps just as quickly as it would form at the oral end if we prevent the formation of the oral polyp by cutting off the oxygen supply at this end. Hence the suppression of the formation of the oral polyp accelerates the formation of the aboral polyp; and, conversely, the formation of the oral polyp retards the formation of the aboral polyp. This might at first appear to be explainable on the assumption that only a limited amount of material for polyp formation was present in the stem, but this assumption is rendered untenable by the fact that if we cut the stem into a number of pieces each piece will form two polyps, the oral one always more quickly than the aboral one. This shows that the stem has material enough not for two, but, if necessary, for a dozen polyps or more. We understand the facts, however, on the assumption that the material necessary to induce the cells at the front edge to grow into a polyp collects first at this end and is held here; and that only later it can also gather at the opposite end. This is almost the same assumption as that made to explain the phenomena in *Bryophyllum*. But in the case of *Tubularia* the visible phenomena directly support our assumption. I noticed that the formation of a polyp is always preceded by a dense collection of certain pigmented cells from the entoderm which are carried like the blood corpuscles of higher animals in the fluid which circulates through the stem. These red or yellowish cells always collect first at the oral end of a piece cut out from a stem of a *Tubularia*, but if we withdraw the oxygen from this end they collect at once at the aboral end. I mentioned that the tips of stolons may grow out into polyps without a wound. Whenever this happens the formation of a polyp is preceded by a gathering of the red cells in this tip. The question then arises: Why do these red cells gather first at the oral end of a cut piece of the stem? I am not in a position to give a definite answer to this question. I suspect that phenomena of agglutination may play a rôle in this case. All I wanted to indicate was the connection which exists between the transport of special material and the localization and inducement to growth.[9]

[9] These older observations of the writer may possibly assume a greater significance in view of the work of Jas. B. Murphy concerning the rôle of lymphocytes in the prevention of the growth of

I am inclined to see another confirmation of this interpretation in a well-known observation of Morgan on the regeneration of *Planarians*. He found that if a piece be cut from the body at right angles to the longitudinal axis the head will form along the whole cut edge of the piece, while if a piece be cut out obliquely a tiny head will form in the foremost corner of the cut edge. As Bardeen suggested, this would find its explanation on the assumption that the head formation is induced by the collection of certain material which will collect along the whole front when the piece is cut out of the body at right angles, while it is bound to collect in the foremost angle when the piece is cut out obliquely.

VI

When we summarize all the facts we may state that it may be inherent in each cell to grow and divide eternally under suitable conditions; and that we can understand this condition on the simple assumption of the existence of synthetic ferments or synthetic mechanisms in each cell which are formed from the food taken up by the cells. In reality, however, things do not happen in this way in multicellular organisms, and not even in their egg cells. The unfertilized egg can in most cases not grow even under the most favorable conditions and is doomed to die in spite of its potential immortality, unless it is fertilized or treated with the methods of artificical parthenogenesis. The condition of rest or growth depends in this case apparently upon the condition of the cortical layer of the egg and the alteration in the rate of oxidations connected with this condition.

In the body, cells may be at rest or growing, and we do not know whether the conditions which determine rest are identical with those determining rest in the egg. We know, however, that specific substances circulating in the blood can induce certain resting cells in the body to grow and that these substances differ apparently for different types of cells. It may be that in the body substances antagonistic to these may enforce the inactivity of the cells.

foreign cells in a body, to which reference was made in an earlier part of this paper.

And finally we come to the conclusion that the circulation in animals or the flow of substances in plants is an important factor in the phenomena of cell rest and cell growth, inasmuch as circulation or flow determine or influence the distribution of formed cells or non-formed elements which induce or influence growth. The phenomena of regeneration seem to find to a large extent their explanation in the fact that a wound or mutilation leads to a gathering of formed or non-formed elements in spots where without the mutilation they would or could not have collected.

Jacques Loeb

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ALASKA SURVEYS AND INVESTIGATIONS

The United States Geological Survey is dispatching 12 parties to Alaska to continue the systematic surveys and investigations that have been in progress for the last eighteen years. Of these parties three will be sent to southeastern Alaska, one into upper Chitina region, one to Port Valdez; two will work in the Turnagain Arm-Knik region; one will make investigations in the Yukon-Tanana region, and two in the Ruby-Kuskokwim region, and another will traverse the little-known area lying between the Ruby district and the Tanana River. One party will be engaged in general investigations in different parts of the Territory. These parties will sail from Seattle during May, so as to take full advantage of the field season. All the men needed for the work have been engaged, and the pur-

chase of horses, supplies and equipment is well under way.

One of the most important of the undertakings is the extension of the surveys in the Ruby district, on the Yukon, and in the adjacent regions. C. E. Griffin and G. L. Harrington will undertake the surveys in the Ruby district proper, which is now an important gold-placer camp. R. H. Sargent and J. B. Mertie will carry surveys southward to Takotna, on Kuskokwim River. H. M. Eakin will explore the region lying between the mouth of Cosna River, a tributary of the Tanana, and the Ruby district. The only other work in the Yukon basin is that of Eliot Blackwelder, who will make a geologic examination of the White Mountains, southwest of Circle.

The region lying between Knik and Turnagain Arm, tributary to the proposed government railroad, has been only partly mapped, and here both geologic and topographic surveys will be undertaken. The preparation of the topographic base map will be undertaken by one party under the leadership of J. W. Bagley, and the geology and mineral resources will be studied by another party under S. R. Capps.

B. L. Johnson will complete his detailed study of the geology and mineral resources of the Port Valdez district and will also investigate the mineral resources of other parts of the Prince William Sound region.

Much of the Copper River region has been surveyed in previous years. There still remains, however, the upper Chitina basin, where no geologic work has been done. This work will be undertaken by F. H. Moffit, assisted by R. M. Overbeck.

The detailed topographic mapping adjacent to Juneau, in southeastern Alaska, begun last year, will be continued by D. C. Witherspoon. The base map of this important gold lode district is essential to an exhaustive study of the district which will be undertaken next year.

The mineral resources of the Ketchikan district have been under investigation at different times in the last fifteen years, and the results embodied in reports. Detailed surveys of the two most important copper-bearing areas of the Ketchikan district have been made. Much of the district has been geologically mapped, but the work is still far from being complete, and the investigation of the geology and mineral resources in this field is to be extended by Theodore Chapin.

The marked industrial advancement in southeastern Alaska has created a great demand for information about the available water-powers, which George H. Canfield has been detailed to investigate. He will also carry on stream gaging in cooperation with the Forest Service.

The hot springs of Alaska are of importance, as many are used as local sanitariums. As no information about them is available, they are to be investigated this summer by G. A. Waring, who will visit the hot springs of Ketchikan and Sitka, in southeastern Alaska; one near Circle and the Baker and Chena hot springs, in the Tanana Valley; and one in Seward Peninsula, about 60 miles north of Nome.

Alfred H. Brooks, geologist in charge of the survey's Alaska investigations, will be engaged in office work until about the end of June. He will then leave for Alaska, and his work will probably include investigations in the Iditarod, Fairbanks and Valdez districts.

AT THE OHIO STATE UNIVERSITY

The following letters have been exchanged between the president of the Ohio State University and the dean of the College of Agriculture:

OHIO STATE UNIVERSITY,
COLUMBUS

My dear Professor Price: Since your remark this morning that you would not remain as professor of rural economics I feel impelled to write you and make an urgent appeal for you to reconsider that decision. My judgment is that you have a quarter of a century of service ahead of you here in a field not well occupied anywhere in the country. You have the esteem and good will as well as the confidence of your colleagues. I can not but feel that you would be sacrificing a highly useful career if you should leave the uni-

versity. It would give me personal satisfaction and pleasure to nominate you at the maximum salary. It would be a great disappointment to me and I think also to your friends if you should persist in your determination to leave the service in the university.

Think this matter over deliberately and let me have assurance of your willingness to remain.

Very cordially,
W. O. THOMPSON

April 21, 1915

April 27, 1915

PRESIDENT W. O. THOMPSON,
Campus.

My dear President Thompson: Your letter of April 21 came to hand and I have delayed answering it until I had time to consult with some men, both on the campus and off of it, who have the welfare of the university at heart, and men in whom I know you have confidence.

I have thought the matter over carefully and what I have to say is said deliberately and without feeling. In answering your urgent appeal to remain in the university I can not refrain from reviewing some of the things that have happened in the college of agriculture during the twelve years that I have been dean.

I came here twelve years ago to fill the position of dean. I had only been out of college six years, most of my associates and colleagues had been my teachers. The college was small, the enrollment was only 243, about one seventh of the total enrollment of the university. The esteem in which the college was held in university circles was not high. Townshend Hall and the old horticultural building represented the material equipment of the college. No winter courses were given, no extension work was done, no farmers' week was held, no three-year courses existed and combination courses with other colleges were unthought of. This year the enrollment in the college is 1,478, nearly one third of the total enrollment of the university. The college of agriculture of Ohio State University is surpassed in enrollment, as reported in a recent number of SCIENCE, only by Cornell and the University of Wisconsin. The standards of the college of agriculture have been raised, five buildings have been built, 250 acres of land have been added to the university farm. Most cordial relations exist with all the agricultural organizations of the state, and the work is held in high esteem by the farmers.

All of this progress and development has not been due to the work of any one man, but rather to the faithful, conscientious work of every one connected with the college, but I insist that in this growth and development I have done my share.

To be summarily demoted without assigning any cause and without explanation, as was done by the recent action of the board of trustees, I resent. I believe that I, my associates and colleagues, and the people of the state are entitled to know why such action was taken.

It is not that I am enamored with administrative work, but one thing for which I have always prided myself has been frank, open dealing with every one and I do not feel that I have been accorded such treatment by you and the board of trustees. However, I could overlook all of that and take up the work of a department if I thought conditions justified it. But I believe that conditions in the university are fundamentally wrong in that the encroachment of the business administration upon the academic has brought about a condition that is rapidly growing intolerable to members of the faculty. Such action as the board has recently taken in reference to me will intimidate your faculty, but it will not give it a sense of permanency that is conducive to constructive, efficient work, neither does it develop the spirit of loyalty.

I appreciate the cordial request that you have made of me to remain in the faculty. But under conditions as they now exist I do not believe it would be wise and very respectfully decline.

It is not without regret and heartaches that I lay down the work of the college in which I have invested my very self for the past twelve years. In retiring I do so without apologies for what has been accomplished during my administration, and I sincerely hope that my successor may have more loyal support from the president and the board of trustees than I have had.

I am, Very truly yours,
HOMER C. PRICE,
Dean

P. S.—As a matter of information I am referring copies of this correspondence to members of the board of trustees and to the president of the alumni association and am giving it to the press.

THE WASHINGTON UNIVERSITY MEDICAL SCHOOL

On the 29th and 30th of April the new buildings of the Washington University Med-

ical School in St. Louis were dedicated. On the morning of the 29th exercises were held in the Assembly Hall of the school at which the keys of the buildings were formally presented to the acting chancellor of the university by the architect. The visiting delegates were then presented to the chancellor and president of the corporation. The delegates were as follows:

Harvard University: President Abbott Lawrence Lowell.

Yale University: Dean George Blumer.

University of Pennsylvania: Dean William Pepper.

Brown University: Mr. Augustus Levi Abbott.

University of Pittsburgh: Dean Thomas Shaw Arbuthnot.

St. Louis University: Dean Hanau Wolf Loeb.

Medical Corps of the United States Army: Captain Thomas Dupuy Woodson.

Western Reserve University: Dean Carl August Hamann.

Lafayette College: President John Henry MacCracken.

Tulane University of Louisiana: Professor Rudolph Matas.

St. Louis Medical Society: Dr. Robert Emmet Kane.

Knox College: President MacClelland.

University of Michigan: Professor Frederick George Novy.

University of Missouri: Acting-Dean Guy Lincoln Noyes.

University of Bellevue Hospital Medical College: Vice-Dean Samuel Albertus Brown.

New York Academy of Medicine: Dr. Edward Dix Fisher.

Missouri State Medical Association: Dr. Frank Joseph Lutz.

The University of Edinburgh: Professor Lindsay Stephan Milne, University of Kansas.

Central Wesleyan College: President Otto Edward Kriege, Professor Albert William Ebeling.

Detroit College of Medicine and Surgery: Dean B. R. Shurley, Professor Charles Godwin Jennings.

Purdue University: Professor Oliver Perkins Terry.

University of Minnesota: Professor James Edward Moore.

Drury College: President James Gilmer McMurtry.

University of Cincinnati: Professor John Ernest Greiwe, Dr. Christian Holmes.

Johns Hopkins University: Professor Theodore Janeway.

Missouri Valley College: Mr. Alphonzo Chase Stewart.

Missouri Botanical Garden: Professor George Thomas Moore.

Leland Stanford Junior University: Dr. Harold Phillip Kuhn.

Dennison University: Dr. E. B. Packer.

University of Kansas: Professor John Sundwall.

Rockefeller Institute for Medical Research: Dr. Simon Flexner.

Memorial Institute for Infectious Diseases and Rush Medical College: Dr. James Bryan Herrick.

American College of Surgeons: Dr. Major Gabriel Seelig.

University of Illinois: Dr. Dean D. K. A. Steele, Professor A. C. Eycleshymer.

An address was then made by Dean Opie, of the Medical School, who outlined the early history and reorganization of the school and the ideals which it represents. He was followed by Dr. William H. Welch, of Johns Hopkins, who spoke of the development of clinical teaching in American medical education and of the success which had attended the introduction of full-time clinical teaching at Johns Hopkins, and which is under consideration at Washington University.

After-luncheon addresses were made on the lawn of the medical school by President Lowell, of Harvard, and President Vincent, of the University of Minnesota. Dr. Lowell spoke on the importance of preventive medicine as a public service, and of the necessity of a broad general education as a basis for the training of the physician. Dr. Vincent spoke of the position graduate studies should hold in medical education. Dr. Henry S. Pritchett, president of the Carnegie Foundation for the Advancement of Teaching, the third essayist of the afternoon, was unable to be present and his paper was read by Professor Lowes, of the college faculty. His paper was on "Medical Education in Missouri." After the addresses the guests of the university were entertained at a garden party.

In the evening a banquet was held at the St. Louis Club at which Mr. Robert S. Brookings, president of the corporation of Washington University presided. Responses to toasts were made by President Hill, of the University of Missouri, former Governor David R. Francis, Dr. Abraham Jacobi and Dr. W. H. Howell.

Friday the 30th was known as Alumni Day and in the morning talks were given by Dr. W. T. Porter in behalf of the alumni of the St. Louis Medical College, and Dr. Robert Terry in behalf of the alumni of the Missouri Medical College. These two institutions were united to form the Washington University School in 1899. Dr. Fred T. Murphy then spoke to the alumni in behalf of the medical school faculty.

In the afternoon Dr. Geo. Dock spoke on the relation of the academic hospital to the community. He was followed by Surgeon General W. C. Gorgas who spoke on the eradication of yellow fever and malaria in Havana and in the Canal Zone, and the possibilities that preventive medicine holds for the future.

In the evening academic exercises were held in the university chapel on the university campus followed by a reception in the building of the school of fine arts. The following honorary degrees were given at the exercises:

Doctor of Science: Dr. W. T. Porter; Dr. O. E. Folin, and Dr. Theodore Janeway.

Doctor of Laws: Professor R. H. Chittenden, Dr. W. C. Gorgas, President H. R. Hill, President A. L. Lowell, President George E. Vincent, Dr. F. P. Mall, Dr. Abraham Jacobi, Dr. Simon Flexner, Dr. W. H. Welch, Dr. S. J. Meltzer, Professor W. H. Howell, Dr. Rudolph Matas.

Doctor of Laws (in absentia): Professor Nathaniel Wille, University of Christiania.

Opportunity was provided in the program for the inspection of the laboratories of the medical school and the affiliated Barnes and St. Louis Children's Hospitals. The laboratories were opened in September and consist of two four-story and basement buildings 209×56 feet. In the north building are located the administrative offices, library, assembly hall, laboratories of preventive medicine and surgery and the department of anatomy. The south building is occupied by biological chemistry, physiology and pharmacology. A third building five stories in height and 232×60 feet which completes the group is on the hospital lot directly across the street from the other laboratory buildings. The basement and first floors are occupied by the out-patient dispensaries of the hospitals. On the second floor is located the clinical laboratory of the department of medicine, while the department of pathology occupies the third and fourth floors. Animal quarters and runways are provided on the roofs of all the buildings. The three laboratory buildings were erected at a cost of $1,200,000 which brings the outlay for new buildings for the medical school, including the hospitals, to over $3,000,000.

One of the interesting features of dedication week was the presentation to the Washington University Medical School of a number of manuscripts and papers of William Beaumont by his granddaughter Miss Irwin. Included among these are the original manuscripts and notes of Beaumont's experiments upon Alexis St. Martin and the agreement entered into by St. Martin to accompany Beaumont, for a period of two years for the purpose of experimentation. Dr. F. J. Lutz spoke of Beaumont as a practitioner and Dr. Joseph Erlanger on Beaumont as an investigator. A room has been set aside in the library of the medical school to house the manuscripts, known as the Beaumont room.

On April 28 Dr. Simon Flexner delivered a popular lecture before the Washington University Association on "The Control of Infective Diseases."

In connection with dedication week of the medical school of Washington University a series of four lectures on "Protein Metabolism" was delivered by Dr. Otto K. Folin. The subjects were as follows:

"The Utilization of Food Protein."

"Tissue Metabolism with Special Reference to Creatinin."

"Protein Metabolism with Special Reference to Uric Acid."

"The Occurrence and Significance of Phenols and Phenol Derivatives in the Urine."

SCIENTIFIC NOTES AND NEWS

For the meeting of the British Association to be held at Manchester from September 7 to September 11 next, under the presidency of Professor Arthur Schuster, Sec. R. S., the following sectional presidents have been appointed: Section A (mathematics and physics), Sir F. D. Dyson; B (chemistry), Professor H. B. Baker; C (geology), Professor Grenville Cole; D (zoology), Professor E. A. Minchin; E (geography), Capt. H. G. Lyons; F (economics), Dr. W. R. Scott; G (engineering), Dr. H. S. Hele-Shaw; H (anthropology), Dr. C. G. Seligman; I (physiology), Professor W. M. Bayliss; K (botany), Professor W. H. Lang; L (education), Mrs. Henry Sidgwick; M (agriculture), Mr. R. H. Rew. Evening discourses will be delivered by Mr. H. W. T. Wager on the "Behavior of Plants in Response to Light," and by Dr. R. A. Sampson, astronomer royal for Scotland.

A bust of Sir Archibald Geikie will be placed in the Museum of Practical Geology, London, where there are already busts of all previous occupants of the post of director-general of the British Geological Survey and of the museum, as well as of several other distinguished geologists. Sir Archibald Geikie was connected with the survey for nearly forty-six years, during nineteen of which he was director-general. A committee representative of the universities and the principal scientific institutions and societies of the United Kingdom has been formed to carry out the proposal. Contributions for the fund should be made to the honorary treasurer, Mr. J. A. Howe, curator of the Museum of Practical Geology, Jermyn Street, London, S.W.

Dr. Henry S. Munroe, professor of mining in Columbia University and senior professor in the university, will retire from active service at the close of the present academic year. Professor Munroe began teaching at Columbia in 1877 and became professor in mining in 1891.

On April 30 Professor James Monroe Bartlett had completed thirty years of continuous service as chemist of the Maine Agricultural Experiment Station. This period includes the entire history of the station itself. In recognition of this unusual length of service in the same institution a reception in Professor Bartlett's honor was held in the station building on the evening mentioned, and he was presented with a commemorative volume. This volume was composed of a series of congratulatory letters from nearly all of the 109 different persons, now living, who have, at one time or another, been associated with Mr. Bartlett in connection with the work of the station.

At the first annual meeting of the District of Columbia Chapter of the Society of the Sigma Xi the following officers were elected: Marcus Benjamin (Columbia), president; Isaac King Phelps (Yale), vice-president; Marcus Ward Lyon, Jr. (Brown), secretary; Daniel Roberts Harper, 3d (Pennsylvania), treasurer; Frederick Leslie Ransome (California) and Cornelius Lott Shear (Nebraska), councillors.

At the annual convocation of the University of Alberta, in Edmonton, on April 28, the honorary degree of D.Sc. was conferred on Mr. W. F. Ferrier, mining engineer and geologist of Toronto. Mr. Ferrier was for nine years an officer of the Geological Survey of Canada. He has made extensive donations to the museum collections at the University of Alberta and has assisted in building up the Geological Museum equipment.

The Adams prize of the value of about $1,200 for 1913–14, has been awarded by the University of Cambridge to Mr. G. I. Taylor, Smith's Prizeman in 1910. The subject selected was "The Phenomena of the Disturbed Motion of Fluids, including the Resistances encountered by bodies moving through them."

According to a Paris cablegram the French Institute has announced that the Osiris prize, which this year amounts to $36,600 because no award was made in 1912, has been awarded chiefly for discoveries in medicine. Drs. Chantemesse and Vidal, discoverers of anti-typhoid vaccines, will divide $10,000, while an equal amount will go to Dr. Vincent, whose researches resulted in the find-

ing of ether vaccine. Various ambulances receive $12,000, and the remainder is placed in reserve.

THE Paris Geographical Society has awarded a gold medal to Dr. J. Scott Keltie for his services to geographical science.

MR. EDWARD W. PARKER, of the United States Geological Survey, for many years the government coal statistician of the division of mineral resources, leaves the government service to accept a responsible position with the anthracite mining companies. Mr. H. D. McCaskey has been appointed chief of the division of mineral resources of the survey to succeed Mr. Parker. Mr. McCaskey brings to this position experience, not only as a geologist of the survey since 1907 and section chief since 1912, but also as a mining engineer in the Philippine Mining Bureau from 1900 to 1903, and as chief of that bureau from 1903 to 1906.

DR. JOHN G. BOWMAN has been appointed director of the American College of Surgeons, founded in 1913, an organization of the surgeons of the United States and Canada. Its purpose is the advancement of the art and science of surgery. The executive offices are at 30 North Michigan Avenue, Chicago.

DR. H. T. SUMMERSGILL, superintendent of the University of California Hospital, has succeeded the late Dr. W. O. Mann, of Boston, as president of the American Hospital Association.

SECRETARY of Agriculture Houston has begun an extensive tour of the national forests to find out for himself to what extent their timber, forage, water power, recreational and agricultural resources are being developed for the public under present methods and to make a study of the administrative problems of the forest service. During May he is visiting the forests in several of the western states.

PROFESSOR KOEPLIN RAVN, an authority on the composition of soils, has arrived here from Copenhagen. He comes at the invitation of the department of agriculture and will lecture in a number of American universities on Danish farming methods.

DR. J. N. ROSE, research associate of the Carnegie Institution, accompanied by Mr. Paul G. Russell, of the United States National Museum, left on May 8 on the steamship *Tennyson*, of the Lamport and Holt Line, for South America. They expect to spend the season in Brazil and Argentina, going under the auspices of the Carnegie Institution of Washington and the New York Botanical Garden for the purpose of studying the cactus deserts of those countries. They plan to send large collections of living cacti to the New York Botanical Garden.

THREE Philadelphia surgeons are soon to leave that city for service in military hospitals of France and England. They are Dr. J. William White, surgeon and trustee of the University of Pennsylvania; Dr. R. Tait McKenzie, head of the university department of physical education, and Dr. James P. Hutchinson, surgeon at the Pennsylvania and Bryn Mawr hospitals. Under Dr. White's charge a corps of physicians and nurses will sail next month for France, where they are to form a unit in the American ambulance hospital at Paris. The operating head of the surgical department of the university corps is to be Dr. Hutchinson.

THE University of Pennsylvania Museum has received a report from Dr. Clarence Fisher, leader of the Eckley B. Coxe, Jr., expedition to Egypt under the auspices of the museum, giving an account of the work accomplished up to the early days of March. Pending the arrangements for a large site for operations, Dr. Fisher was permitted to do excavating at the base of the Second Pyramid of Giza (Gizeh), and has had some excellent results.

THE following men have accepted invitations to carry out investigations in Nela Research Laboratory, National Lamp Works of the General Electric Company, during the coming summer: Dr. W. E. Burge, acting head of the department of physiology, University of Illinois; Dr. A. H. Pfund, associate professor of physics, Johns Hopkins University and Dr. S. O. Mast, associate professor of

zoology, Johns Hopkins University. Mr. B. E. Shackelford, fellow in physics in the University of Chicago, has been appointed Charles F. Brush fellow for the summer of 1915.

The annual joint meeting of the Phi Beta Kappa and Sigma Xi honorary societies of the University of Pennsylvania was held in Houston Hall on the evening of May 3. Dr. John A. Brashear made the address on the subject of "Great Telescopes of the World and Discoveries made by their Use." An informal reception followed the address. The societies alternate in choosing a speaker, and this year the choice fell to Sigma Xi.

Dr. Ulric Dahlgren, professor of biology in Princeton University, lectured on May 12 on "The Production of Light by Animals" at the closing exercises of the lecture season of the Wagner Free Institute of Science, Philadelphia.

The monument to be erected to Cesare Lombroso at Verona, the work of the sculptor Bistolfi, was to have been unveiled at the International Pellagra Congress scheduled for next October. As the congress has been postponed until 1916, the committee in charge of the monument has postponed the dedication.

Dr. Jay W. Seaver, for twenty-five years director of the Yale gymnasium and professor of hygiene in the university, died suddenly from heart disease at Berkeley, Cal., on May 5, at the age of sixty years.

William Harlow Reed, curator of the museum and instructor of geology in the University of Wyoming, noted for his collections of vertebrate fossils, died at the age of sixty-seven years on April 24.

Mr. Daniel W. Edgecomb, inventor, astronomer and manufacturer of telescopes, has died at his home at Fairfield, Conn., at the age of seventy-five years.

Mr. Richard Lydekker, F.R.S., known for his work and writings on natural science, died on April 16 at the age of sixty-five years.

Sir William Richard Gowers, F.R.S., eminent as a specialist on diseases of the nervous system, died on May 4, aged seventy years.

Sir Thomas Smith Clouston, a well-known psychiatrist, died at Edinburgh, on April 19, at seventy-five years of age.

Dr. M. Bernhardt, professor of neurology at Berlin, has died at the age of seventy years.

The death is announced in *Nature* of Mr. J. B. A. Légé, who made the first tide-predicting machine for Lord Kelvin. He was the constructor of signaling lamps and other apparatus invented by Admiral Sir Percy Scott and used in the navy. Among Mr. Légé's inventions are horological mechanisms, torpedoes and direct-acting petrol engines.

The next examination for the medical corps of the navy will be held in Washington, Boston, New York, Philadelphia, Norfolk, Va., Charleston, S. C., Great Lakes (Chicago), Ill., Mare Island, Cal., and Puget Sound, Wash., on or about July 6. Candidates for appointment must be citizens of the United States, between 21 and 30 years of age, and graduates of reputable schools of medicine.

The U. S. Civil Service Commission announces an examination for metallographist, for men only, to fill a vacancy in this position for service in the Engineer Experiment Station, Naval Academy, Annapolis, Md., at a salary of $2,500 a year.

The department of geology of New York University has planned a travel tour for the coming summer which will extend through the western part of the United States and a portion of Alaska. The trip is the outcome of a plan which was formulated by the department of geology two years ago. In the summer session of last year, a course of lectures preparatory to the work that will be taken up this year was given, in order that students might obtain the greatest benefit from the trip. The educational conduct of the tour will be under the direction of Dr. Raymond B. Earle, assistant professor of geology in Hunter College. The director of the department of geology in New York University, Dr. J. Edmund Woodman, will exercise general supervision. The tour will extend from July 2 to August 28 and includes a ten-day visit in Yellowstone Park, a trip to Glacier National Park, an excursion to

Alaska, with an opportunity on the return trip to visit San Francisco, Los Angeles, San Diego, Grand Canyon and the Petrified Forests. Two or three other shorter trips have been provided, one taking in Yellowstone Park and the Glacier National Park, and the other ending with the Yellowstone Park. In the case of students specializing in geology, credit will be given for the trip, under certain conditions, in the various schools of the university.

IN connection with the geographical work of the Columbia University summer session, Professor D. W. Johnson will conduct a physiographic excursion in the western United States, next summer. The party will visit the Devil's Tower, Yellowstone National Park, Glacier National Park, Crater Lake, the Yosemite Valley, Royal Gorge of the Arkansas, and the Colorado Springs and Pike's Peak region. It is probable that the new Lassen Peak volcano and the neighboring recent cinder cone will be visited, as well as the Lake Bonneville shorelines and recent fault scarps near Bingham and Provo. While in San Francisco, the party will participate in the excursions of the Geological Society of America to the San Andreas earthquake rift near Point Reyes Station, and the uplift marine terraces at Santa Cruz. Two field courses will be given: a general course on the elements of physical geography and an advanced course on the physiography of the western United States. The courses are open to students and teachers of geology and geography. It is expected that the party will leave New York about the first of July, and be gone two months.

ACCORDING to the American Museum *Journal* Mr. James P. Chapin, of the museum's Congo Expedition, after six years' absence in Africa, has arrived in New York. He brings details of the success of the expedition, not only in the work of a scientific survey but also in having lived without mishap for the extended period of six years amidst the dangers of the equatorial forest and among the negro races of Central Africa—a success due in part to the cordial cooperation of the Belgian government. Mr. Chapin brings with him about one fourth of the expedition's collections. The balance remains in the hands of Mr. Lang, leader of the expedition, who also will come out of the Congo immediately after the final work of packing and shipment is completed. The entire collection numbers some 16,000 specimens of vertebrates alone, 6,000 of which are birds and 5,000 mammals. The specimens are accompanied by some 4,000 pages of descriptive matter and 6,000 photographs. It includes full material and careful studies for museum groups of the okapi, the giant eland and white rhinoceros, besides many specimens of lions, elephants, giraffes, buffaloes, bongos, situtungas, yellow-backed duikers, black forest pigs, giant manis and chimpanzees. The ethnological section of the collection is rich in specimens of native art of the Congo, including several hundred objects of carved ivory, a revelation as to the capacities of the Congo uneducated negro. There are also seventy plaster casts of native faces from the Logo, Azande, Avungura, Mangbetu, Bangba, Anadi, Abarambo, Mayoho, Mabudu, Medje, Mobali and Pygmy tribes. Each cast is supplemented by a series of photographic studies of the individual.

THE 134th meeting of the Science Club, held March 1, 1915, was addressed by Dr. John F. Hayford, director of the college of engineering, Northwestern University, on "The Surveys and the Decision in the Costa Rica-Panama Boundary Arbitration." An innocuous uncertainty regarding the boundary between Spanish colonies became a serious dispute when these colonies became independent of the mother country and of each other, in 1825. The controversy increased in acuteness as the region in doubt became economically more important. The question, after 75 years of contention, was submitted in 1900 to President Loubet, of France, who settled the boundary on the Pacific slope to the satisfaction of both parties, but from lack of geographical information the award gave more territory on the Atlantic side to Colombia than that country had originally claimed, and de-

fined the boundary in terms incapable of interpretation on the ground. After the separation of Panama from Colombia, the question became more acute and threatened to lead to war, when the matter was again submitted to arbitration, before Chief Justice White, of the United States, with the proviso that an accurate survey should be made. The commission of engineers, two representing the parties to the arbitration, two others appointed by the arbitrator, of whom Dr. Hayford was one, accompanied by twenty-one trained assistants and a large number of laborers and porters made the survey in 1911. The survey was made under the greatest difficulty on account of the dense tropical jungle; absence of roads and trails making it necessary to rely on negro and Indian porters for transportation of supplies; and thickness of forest interfering with seeing. Nevertheless an extensive area was accurately covered, and geographical knowledge secured that is of permanent interest and value. A peak more than 12,000 feet high, hitherto unknown, was discovered, and numerous cartographical errors, including the direction of the drainage of a great area, were rectified. The decision, rendered in 1914, chooses the Sixaola River, its tributary the Yorkina, and the southern watershed of the Sixaola as the boundary, instead of the northern watershed of the Sixaola as awarded by President Loubet, and conforms to the *status quo,* since the customs have been collected at that river, and the subjects of the two countries have advanced to it from each side.

UNIVERSITY AND EDUCATIONAL NEWS

Dr. Frank J. Goodnow will be installed as president of the Johns Hopkins University on May 20. On the following day the new university buildings at Homewood will be dedicated. President Wilson will make an address; the engineering buildings will be dedicated with an address by General G. W. Goethals, and the academic buildings with an address by Professor H. C. Adams. It is expected that there will be a full attendance of alumni and former students. The committee having charge of arrangements for the inauguration and dedication is composed of President Goodnow (chairman), Dr. Ralph V. D. Magoffin (secretary), Dr. Joseph S. Ames, Dr. Murray Peabody Brush, Dr. William B. Clark, Dr. William H. Howell, Dr. Basil L. Gildersleeve, Dr. John H. Latane, Mr. George L. Radcliffe and Dr. C. J. Tilden.

The Rensselaer Polytechnic Institute announces that Mrs. Russell Sage has given $100,000 to the school, and Mr. Alfred T. White, of Brooklyn, a graduate, $50,000. The money is to be used in the erection of dormitories and a dining hall.

A trust fund of $5,000 to be known as the "Edward Tuckerman Fund," designed to increase the interest in the study of botany among the students of Amherst College, has been bequeathed to the college by the late Mrs. S. E. S. Tuckerman, wife of the late Professor Edward Tuckerman. Professor Tuckerman, who was a well known lichenologist, was a member of the Amherst faculty from 1858 until his death in 1886, holding a chair in botany and a lectureship in history.

Brown University has received $7,000 from Mrs. Jesse L. Rosenberger, of Chicago, to endow a lectureship for visiting scholars.

Professor H. H. Newman, of the department of zoology, University of Chicago, has been appointed dean in the colleges of science of that institution. The duties involve a supervision of students in the biological sciences, especially of those preparing for the study of medicine.

Dr. Stuart Weller, of the University of Chicago, has been promoted from an associate professorship to a full professorship in the department of geology.

Marcus W. Lyon, Jr., formerly assistant curator, division of mammals, U. S. National Museum, and for the past six years professor of bacteriology at Howard University, has been appointed professor of bacteriology and pathology in the George Washington University.

At Harvard University Dr. Gregory P. Baxter has been promoted to be professor of chemistry, and Dr. John L. Morse to be professor of pediatrics.

DISCUSSION AND CORRESPONDENCE

ISOLATION OF B. RADICICOLA FROM SOIL

TO THE EDITOR OF SCIENCE: I am indebted to Dr. F. Löhnis, of the United States Department of Agriculture, for two corrections which I deem it important to make with reference to the paper by Mr. Fowler and myself in SCIENCE of February 12, 1915, on "The Isolation of *Bacillus radicicola* from the Soil."

The first error is one merely of oversight, and concerns the date in which Beijerinck gave the name *Bacillus radicicola* to the legume-root nodule organism. That date should of course be 1888 and was put down as 1901 merely through carelessness on my part, and I gladly plead guilty to that.

The second error is that which is partially due to our tentative claim to priority in the direct isolation of *Bacillus radicicola* from the soil. Dr. Löhnis informs me that claims were made to the isolation directly from the soil of the organism in question by both Beijerinck and by Nobbe, et al. I do not regard the evidence put forward by Beijerinck as conclusive on that point, but there is no question at all that the second investigator named, with his coworkers, has conclusively demonstrated the presence of *Bacillus radicicola* in the soil and has also, by its isolation in pure culture, been able further to reinoculate plants grown under otherwise sterile conditions. Our neglect to take note of this last-named investigation was due to the manner of indexing pursued in the important abstract journals as well as other scientific journals which gave no useful reference to the work just referred to.

CHAS. B. LIPMAN

A RESEARCH LABORATORY FOR THE PHYSICAL SCIENCES

CONVERSATION with a number of men interested in the biological sciences and who have availed themselves of the opportunity for research work at Woods Hole, Mass., brings out the idea that one great benefit to be derived from the work there is the association with men from all parts of the country. I think all men of science will agree that the great stimulus which comes from the various meetings of scientific bodies is in the private discussion, which the men have, one with the other, on subjects in which they are particularly interested. Think what it would mean to men in the physical sciences if they could have a laboratory where for two or three months each year, at least, they could meet and carry on some research work and at the same time enjoy the fellowship of men who come from widely separated points but who are interested in their particular field.

I realize that the equipment of a laboratory for physics involves a large outlay of money and transportation of apparatus is not easy, but would the first be impossible? In other words, the object of this note is to raise the question as to whether a laboratory for the physical sciences, similar to that for the biological sciences at Woods Hole, would be a feasible and a desirable project. I believe that many chemists and physicists would be very glad to spend their summer vacation at such a laboratory if it were located, as the one at Woods Hole, where there would be a chance for an outing as well. As at Woods Hole, there would be a resident director and the laboratory would be kept open throughout the year for those who might have a year's leave of absence from their work in teaching.

That men of wealth, who would be interested in building and equipping such a laboratory, might be found does not seem such a vagary in view of what has been accomplished for special laboratories.

S. R. WILLIAMS

PHYSICAL LABORATORY,
OBERLIN COLLEGE

SCIENTIFIC BOOKS

The Salton Sea. A study of the geography, the geology, the floristics and the ecology of a desert basin. By D. T. MACDOUGAL and Collaborators. Carnegie Institution of Washington, Publication 193, 1914. 4to. Pp. 182, with plates, maps and figures in the text.

The making of a lake in a desert basin, whose floor lies below the level of the sea-sur-

face is a circumstance which when within the frontiers of civilization is too rare not to attract wide attention, much intensified by a consequent deflection of a trunk line of railway, the loss of an industry of corporation magnitude and the threatening of areas of cultivation. But in spite of vast antagonism, as measured by money and effort, this is what happened when the waters of the Colorado, first as a tiny stream, but at last as a torrent, entered the Salton Sink through the New River during the few years following 1904. If the lack of foresight which led to this is to be deprecated, it is of no meager congratulation that, precisely as the opportunity was afforded, the Desert Laboratory of the Carnegie Institution of Washington was organized and disposed toward the study of the progress of events by scientific methods. This progress is not completed, nor will be for many years, but the careful planning and continuity of study till the present moment, as witnessed by the volume before us, furnish a sure foundation, under the permanency of a stable organization such as the Carnegie Institution, for a future following of events, so that we may confidently hope at the end to have a more complete and accurate account of the complex interplay of events projected over larger places and times than has yet been produced by science. The case illustrates the necessity of the times. Mutual cooperation of students in diverse fields is becoming more and more imperative, if a satisfying solution of any problem is to be had. For a skilful observation of the Salton Sink a geographer, two geologists, several chemists and various kinds of botanists, probably a working minimum, have been needed.

The work under review may be said to have been begun by the late Professor William Phipps Blake, who, as geologist to the official U. S. Railway Survey which in 1853 had the task of exploring the southern portion of the Sierra Nevada, first comprehended the nature of the Salton basin. An account of the region written by Professor Blake only two years before his death, fittingly introduces the reader to the volume. A strong note of human interest is found in a photograph of Professor Blake standing on the travertine formation 53 years after the date of his original discovery of it. There is a historic justice in the fact that Professor Blake was permitted to see serious work begun in this desert, for his vast and intimate experience in the southwestern deserts had been but for his death of great value to it.

The dynamic geography of the region is presented by Mr. Godfrey Sykes, who bases his conclusions on the records of the early explorers, tradition and evidence observed ad hoc. The Salton Sink represents the northern extremity of the Gulf of California which has been cut off by the formation of a huge natural dam, the ridge of which extends from the Algodones Sandhills to Cerro Prieto. If this is true the major beach line identical with that of the present gulf should be, in view of tidal action, 20 to 30 feet higher than sea-level, and in view of prevailing winds, higher on the northeastern shore than on the opposite, and this Mr. Sykes finds to obtain. Rocque's map (1762) indicates that previous to 1762 or thereabout, the Colorado and Gila jointly flowed into an extensive lake, and Indian tradition comports with this. Since 1890 water from the Colorado has at various times found its way into the sink, so that the flooding of recent years was an event following the reopening of a nearly healed wound. When the flood was dammed, the waters found their way chiefly into Hardy's Colorado, and incidentally the Pattie Basin is receiving a part of the surcharge.

A different view is taken by Mr. E. E. Free, who, in a sketch of the geology and soils, regards the evidence that the basin was never occupied by the sea, any further north at any rate than Carrizo Creek. The absence of marine shells, and presence of millions of fresh-water shells, the occurrence of travertine, the amount of salt deposited and the condition at the present time of the major beach all speak for a genetic precursor of the present waters in a fresh water lake, happily called Blake Sea, which has disappeared in comparatively modern times by evaporation. The formation of the dam which excludes the

waters of the gulf has been built up *pari passu* with a subsidence of the region, bringing the lake floor below sea-level. This view, though championed with moderation, is pretty strongly buttressed by evidence. It is, however, evident that more work may profitably be directed to the problem.

It may be noted in passing that the recent flooding of a portion of the alkaline playa soil has not materially altered its salt content. If leaching out has occurred, the evaporation from the newly exposed lake floor has restored the salts to the soil.

The general position based upon geologic evidence taken by Mr. Free receives additional support from the study of the nature and amount of salinity by Dr. W. H. Ross, who finds that the concentrations and solid components of the Salton Sea to be such as to indicate an originally fresh-water body.

The increasing concentration of these various solutes is found by Dr. A. E. Vinson not to have proceeded at equal rates for all. The potassium-sodium ratio has changed, the former element having remained relatively constant while the concentrations of calcium and magnesium have increased at slower rates. The latter fact is explained by the formation of travertine, the composition of which is largely of the salts (carbonate and sulfate) of those elements.

The following paper on the behavior of organisms in brine, by Professor G. J. Peirce is introduced, aside from its intrinsic merit, evidently by reason of its future relevancy to expected conditions in the Salton Sea, as evaporation proceeds to the production of a maximum concentration of solutes.

For a single instance, it will be important to follow the racial history of the bacteria which are the agents of cellulose hydrolyses in submersed plant tissues, as shown in another paper by Dr. M. A. Brannon to occur as agents of disintegration in the Salton waters. The increasing salinity of these waters offers a succession of barriers beyond which only those forms which possess suitable capabilities of physiological adjustment may pass. It is obviously important to determine these capabilities.

The subjects for Dr. Peirce's study were found in the salt ponds on San Francisco Bay. A lively impression of the wide adaptability of the living organism is had from the persistence of numerous minute green algæ and bacteria which inhabit their waters at whatever concentrations. Of these a chromogenic bacterium responsible for the red coloration of salted codfish, has been isolated and shown to be the cause of the color of the brine and salt. It will come as a shock to those who have supposed a complete preservation to be effected by salting to know that decay may still proceed in fish saturated with salt if exposed to humid air and a moderate temperature. The fluctuations in concentration and composition of the waters of "pickle ponds" and salterns strongly umbrate the theory of balance in solutions, since it is difficult to believe that such relations can here obtain. It was also found that cell division in the protophytes varies inversely to the concentration, being halted by the higher, and stimulated by a lowering.

The deposits of tufa which characterize most markedly a vertical zone 200 feet deep, limited above by the major beach line of Blake Sea, were studied by Dr. J. Claude T. Jones, who shows conclusively its origin to be in the activity of minute algæ vegetation (*Calothrix* sp.). By a method not yet understood, certain organisms, *e. g., Chara,* caused the calcium salts to be thrown out of solution in their immediate neighborhood. When the organisms are minute and very numerous a *quasi* continuous material (sinter) is formed, found however to possess a structure which may be regarded, in a rough sense, as coralline. Imbedded in the tufa of the Salton are found snail shells. Here therefore is further evidence of the freshwater character of the Blake Sea. The study of tufas on the slopes of ancient lakes must reveal much sure information of their previous history.

Mr. S. B. Parish contributes a paper on the "Plant Ecology and Floristics of the Salton Sink." His long previous acquaintance with the flora of the southwestern deserts places him in a position to offer a particularly complete statistical study of that portion of it included in the region in question. Of 202 species listed, 48 are introduced, and of these it is

important to note that not one has been able to establish itself under constant natural conditions. Of the remaining 131, all but six or seven are more or less widely distributed, chiefly in the surrounding country. But these few appear to be endemic, as they have not been found elsewhere. The suggestion is obvious that these have originated in the sink during comparatively recent times, while it is further pointed out by Dr. MacDougal that other species may have similarly arisen, but have succeeded in passing outwardly beyond the limits of their original home. There is an approach here to something like quantitative relations between geological age and the possible number of new specific origins.

It seems equally probable that other plants, such as the desert palm *Washingtonia filifera* and *Populus Macdougalii*, are to be referred, as to their origin, to comparatively recent dates, and this locality.

The absence of succulent xerophytes, including under this term those with water-storage roots, from this very pronounced desert region is worthy of remark, since, in the minds of many, succulence is regarded as the final expression of desert adaptation. Here the xerophytic shrub with spinose parts and other appropriate characters are the chief perennial inhabitants of the slopes and older strands, while the salt-laden alluvium of the sink-floor bears a zone of the salt-bushes, *Atriplex* spp.

The final paper of the series concerns the movements of the vegetation due to submersion and desiccation and is by Dr. D. T. MacDougal, under whose leadership the whole work has been carried forward. Recognizing the importance of the opportunity to observe the advance of plants upon an immense sterilized area especially in view of the inadequate study or total neglect of analogous earlier opportunities (one thinks of the lost one of Mont Pelée), the lavas of Hawaii, studied by C. N. Forbes excepted, the task was laid out on a comprehensive but workable scale. Sample areas or "belt transects," a mile in width, normal to the beach lines, were chosen, and these, together with sterilized islands, afforded the basis for exhaustive study. This, as the reader will have understood from what has already been said, embraced not only the vegetation, but the salt content of soil and water and other relations. Usually semi-annual visits were made for the collection of data.

The first half of the paper presents the facts concerning the reoccupation of the strands of six successive years, and a partial study of another, namely, 1913. The earlier strands of Blake Sea, untouched by the recent invasion of waters, afforded a standard for comparison, so that it was possible to measure the rate at which the facies of the new strands took on the same composition as obtains now in the old, relatively static strands. It was observed that the recession of the water was so soon followed by desiccation of the soil that wholly desert conditions were established in the course of a couple of years, and that, in consequence, the introduction of xerophytes identical with those characteristic of the ancient Blake Sea strands had been accomplished in the course of three or four years. The change from close to open formation was similarly rapid.

The transition from one environment to another as the established desert gives way to strand, and the gradual alteration of successive zones correlated with the recession of the water, together with the separation of shore and sterilized islands by extensive water ways, sets up conditions for the study of methods of dissemination and of natural selection as well as reoccupation. It is of more than incidental importance that the reoccupation of islands, and of one shore from another, was among other methods possible chiefly by the flotation of seeds and fruits as proved by many experimental tests. It is clear that in this can be seen no causal relation between the conditions and the "adaptations to flotation." Nature had otherwise been peculiarly far-sighted in furnishing to desert plants not only adaptations in harmony with their immediate surroundings, but with a possibility so remote as the occurrence of a lake! Causal relations are, however, to be seen probably in such characters as reduced superficies, thickened outer tissues, and the like, as a direct result of evaporation, and a number of such correlations have been

or can be made the subject of experimental investigation. To what extent the colloidal substances of cells, such as the mucilage dissolved in the sap, can be made use of, and how this use may be modified by the acid or alkaline content of the disperse medium is at present almost or quite unknown. The great size of tannin idioplasts and the imbibitional avidity of their colloidal content may, it is quite possible, be related, and it is similarly possible that the growth and therefore the size of other cells may depend not only on the "turgor" relations, but even more upon the imbibition pressure exerted upon their walls. The mucilage and other colloidal content of desert succulents *par excellence* may in this light take on greater significance in view of Borowikow's work, cited by MacDougal.

Much more of detail from this collection of papers could be given with more ease than to indicate, without giving an impression of meagerness in the source, the most salient points. Many people untaught in the thought of the scientist have expected vast changes in the surrounding country to follow the flooding of a large desert-inclosed area. The emersed bed of Blake Sea is, however, still a desert, and as measurement and even more superficial observation shows, the evaporation from the many square miles of water surface has had no smallest effect upon any vegetation but that immediately following recedence of the water itself. A very short span of time and the desert is restored to its own. But the opportunity of seeing what does happen has fortunately been seized, and we have in this review seen, it is hoped, that a result of signal value has rewarded.

FRANCIS E. LLOYD

McGILL UNIVERSITY

SCIENTIFIC RESEARCH AND SIGMA XI[1]

BEFORE the chapter reports are presented, it is my business for twenty minutes to address you, yours to listen; for Sigma Xi too expects every man to do his duty. We have eaten; water has been served; it is a pity that we can not now be merry. For whatever may happen to us, Sigma Xi will not die to-morrow. We have long since passed through the dangerous period of infancy; at the age of twenty-seven the death-rate is but five per thousand. And we surely are a chosen people; like the patriarchs of old, the years of our life are measured not by decenniums but by centuries.

Our first quarter century has indeed been a period of marvelous growth and fruition. As exhibited in the record and history admirably compiled by our secretary, it is one of the fairy tales of science, incredible if it were not true. The beginnings at Cornell University were small, but, like the zygote, they contained the elements which in interaction with a fit environment grew into the great organism, of which each of us is one seven-thousandth. Unlike the individuals of the species to which we belong, our corporate growth does not stop at the age of twenty-five, nor will senility follow fifty years of activity.

In a recent article an eminent American statistician states that 30.7 per cent. of Rhode Island native-born married Protestant mothers are childless. The distinguished dean of a great woman's college within a thousand miles of Philadelphia in a chapel address to the students said that it is not just to charge the decreasing birth rate to the higher education of women; although the college had been established only a few years, forty per cent. of its alumnæ were married and sixty per cent. of them had children. When birth-rate statistics are so complicated, it may not be safe to state that we are all the children of Henry Shaler Williams. But this is true, though polyandry appears on the records and we have certainly had polygamous nursing. We may indeed regard our leaders and each of us as somas of the immortal germ plasm, which seeks the light of truth:

> That light whose smile kindles the universe,
> That beauty in which all things work and move.

As a hand apart from the body is not a hand, as a man apart from other men is not a man, so a scientific man is not conceivable

[1] Remarks by the president of the Society of the Sigma Xi at the annual dinner given at the University of Pennsylvania on January 4, 1915.

apart from the long line of scientific worthies, great and small, who have bequeathed to us our present heritage, or from his fellow workers, old and young, without whose sympathy and cooperation no research would be possible. Our society has been founded to personify and promote the spirit of comradeship and zeal which is essential to scientific research. A century earlier, Phi Beta Kappa was established to encourage and reward scholarship in our colleges. It may be desirable to maintain the tradition of classical learning, but as service is better than culture, as the future is of greater concern than the past, so creative science is more than passive scholarship.

The activities of Sigma Xi with which I have indeed least sympathy are those which we have inherited from Phi Beta Kappa. It is a pity that we did not find an honest English name. How many of us know whether Ξυνῶνες means companions, or zealous or research? I happen to be one of the small minority of our members who read Greek for professional purposes after leaving college, but I do not know the orthodox way to pronounce our initials. In the presence of these modern Greek mysteries, one feels like the little girl who, being sent to school for the first time, rushed home on hearing the older boys recite: At 'er, beat 'er, jam 'er, eat 'er.

A pendant gold key suitably engraved is too reminiscent of the dueling scars on a face made and marred in Germany, a personally conducted advertisement of a past university student and presumably member of a corps. It has been suggested that the proposed class of associates might be entitled to wear only a smaller key. Why not let the professor carry one three inches long, and if he should become a president, make it a foot long, even though four to one would inadequately represent the difference in eminence and ability to pay for the gold? The badge may be a convenient way to pick up a congenial acquaintance in a smoking car; but would it not be better to wear a more extended label to the effect that I am not only Sigma Xi and Phi Beta Kappa too, but also a teacher of psychology, interested especially in science, education and democracy, but ready to talk about almost anything except golf and psychical research?

It is better to select and distinguish students for promise or performance in research than for high grades in classes. If interest in research or scholarship can be stimulated by such rewards they are legitimate. But when we embroider with gold braid, we are likely to bind with red tape. I wonder whether a single piece of research work has been conducted or improved because it might lead to election to the National Academy of Sciences or to an honorary university degree. The University of Königsberg has conferred the degree of its four faculties on General von Hindenburg for driving the enemy from the gates of the city, but it may be doubted whether even the doctorate of divinity will be of great assistance to him in checking the invasion. Like old china or other bric-a-brac in a laboratory, all such inherited and artificial distinctions are out of place in a democracy. If members of the National Academy received a salary for useful services, or if membership in Sigma Xi enabled students to go on with their researches then the election would be useful and desirable. It would from my point of view be better if membership in Sigma Xi depended on the option and efforts of the student and the scientific man, such as attendance at meetings and the presentation of a paper.

Even the separation of the academic sheep from the philistine goats does not seem to be a desirable segregation. A college and university education is certainly at present the gateway through which they must pass who wish to follow the paths of scientific research. But from some points of view, this is an evil necessity rather than an ideal condition. It is costly in money and precious years, in initiative and originality. The two greatest scientific men whom we have known, Simon Newcomb and William James, did not enjoy or suffer the orthodox college or university education; the same is true of the two living Americans responsible for the most important applications of science—Mr. Edison and Mr. Bell. If two academic degrees were required —four years of college culture and four years

of professional training—before the poet, the novelist, the musician, or the artist could become productive, what would be left of the literature and the art of the world? It is a system of privilege when only those can enter the professions whose parents are able to support them to the age of twenty-seven years; it postpones too long family duties and civic responsibility, and those who travel long over well-worn ways may accumulate baggage and habits which burden rather than help the exploration of new territory.

Your to-night's figurehead has been accused of being habitually "agin the administrashun," but in intention at least he is radical only as to ends, while reasonably conservative as to means. Our Society of Sigma Xi, like the university of which it is a part and much else that is best in our civilization, is a heritage handed down to us from other days and other ways, only partly adjusted to a democracy in the twentieth century. Institutions and customs should not be bent until they break; they should be permitted to reach toward the light by their own gradual growth. We can not live in a true democracy until it exists, and in the meanwhile we must do the best we can with our inherited institutions and human nature. Our society has in several directions led the way—in placing research before high grades in class work, in uniting those showing the beginnings of aptitude for research work with productive scientific men, in emphasizing and promoting the comradeship and common interests of scientific workers, in arranging scientific meetings and lectures to which all are welcome, in putting applied science on terms of equality with other research, lastly and chiefly in being one of the active agencies contributing to scientific advance.

It is anti-democratic to hold that culture is precious because it can be attained only by those having wealth and leisure, that science is noble only when it is useless. The mathematician who thanked God that his geometry was a virgin that had never been prostituted by being put to any use did not stay in America longer than he could help. Pure science may proceed on a long orbit, but it can not go off on a tangent to the real things of life. Our society has served both science and democracy by placing engineering on terms of equality with other sciences. The distinction is not between scientific discovery and practical applications, but between the discovery of new truths or new ways of doing things and the repetition of those already learned; not between the pathologist who studies diseases and the one who finds cures, but between the experimental pathologist and the routine practising physician; not between the engineer who builds bridges and the one who writes about bridges, but between the scientific man who devises new methods and the builder who copies old models. Adopting what Francis Bacon wrote in another connection:

> These two subjects, which on account of the narrowness of men's views and the traditions of professors have been so long dissevered, are, in fact, one and the same thing, and compose one body of science.

And most of all, this Society of the Sigma Xi has served democracy and science by emphasizing research work at the outset of the student's career and as the essential life work of each of our members. It is our business to promote scientific research by every method and by every motive. A correct statement of the economic value of science to society would at first sight seem incredible. It is safe to say that the applications of science have quadrupled the productivity of labor and doubled the length of human life, though it is not possible to give the exact period from which this result is reckoned. The writer would guess that so much progress has been made within from one hundred to one hundred and fifty years. In some kinds of work, as in the transportation of freight over land and some kinds of machinofacturing, the efficiency of labor has been increased a hundredfold; in others, as in agriculture, it may have been only doubled. In the period during which the efficiency of labor has been quadrupled by modern science, the annual production of wealth in the civilized world has perhaps been increased a hundred billion dollars, representing

a capital sum of two thousand billion dollars.[2] A great part of this advance is due to a few men, probably one half of it to, at most, 10,000 men. The value of each of these men to the world has been a hundred million dollars; they have been men not abler nor more productive on the average than the upper five hundred of our leading American men of science.

So far from being exaggerated this valuation of science and of scientific men neglects the decrease of disease and suffering, the increased length of life and the vast number of human beings for whom life has been made possible. It can not take account of the moral, intellectual, political and social changes wrought by science and its applications. Science has made democracy possible and has given us as much of it as we have. The applications of science have abolished the necessity of continuous manual labor from childhood to old age, they have made feasible universal education, equality of opportunity and equality of privilege, they have banished legal slavery, they have partly done away with the labor of children and the subjection of women. Science has given us freedom in the moral as well as in the material world, freedom from ignorance, superstition and unreason, the means of learning the truth and the right to tell it.

The service of science for the world is by no means complete. The productivity of labor can be again doubled by further scientific discovery; it can be more than doubled by the selection of the right men for the work they do and by correct methods of work. The value of wealth can be doubled by its proper distribution and use. Warfare, preventable disease and vice, waste and display, the futile complications of civilization, consume one half of all the wealth that is produced. We do not know the conditions of happiness and real welfare or how they are to be attained. Science should continue to press to the limit economy of production and the conservation of health and life; at the same time it should increasingly direct its methods to the control of human conduct.

> Suddenly, out of its stale and drowsy lair, the lair of slaves,
> Like lightning it leapt forth half startled at itself,
> Its feet upon the ashes and the rags, its hands tight to the throats of kings.

On us here in America there has been thrust the duty and the privilege to carry forward the flickering torch of science and of civilization. Our society of the Sigma Xi and each of us have indeed great opportunity and great responsibility.

J. McKeen Cattell

[2] This enormous figure is based on the assumption that there are 25,000,000 people in the United States, whose productive work is worth on the average $1,000 a year and six times as many in the civilized world who earn on the average half so much, with enough left over to balance the earnings of 100 years ago.

RADIUM FERTILIZER IN FIELD TESTS

With the discovery of radio-activity by Becquerel, in 1896, and of radium itself by M. and Mme. Curie, in 1898, science revealed a property of matter and a source of energy hitherto unknown; and the facts already established, the predictions or claims made, and the general interest in the subject seemed to justify an investigation under field conditions of the possible value of radium as a fertilizer, or of radio-activity as a crop stimulant.

While possessing most of the properties of an element, reacting chemically very similarly to the element barium, radium also has the remarkable property of continuous disintegration, by continuous emanation of particles, which is accompanied by radiation of energy, called radio-activity.

Investigations show that one gram of radium emits enough heat to raise 118 grams of water one degree centigrade in one hour, or 118 calories, and indicate about enough total energy to decompose one gram of water into hydrogen and oxygen every twenty-four hours, equivalent to more than 3,800 calories, or nearly 160 calories per hour. This radiation continues hour after hour with gradual reduction to ½ the quantity in about 1,760 years, to ¼ in

3,520 years, to $\frac{1}{8}$ in 5,280 years, and so on. Thus the total energy ultimately evolved from 1 pound of radium is equivalent to more than 70,000 twenty-four-hour days of horse-power.

Many experiments have been made to ascertain the effect of radio-activity on plant growth; and in general a distinct influence is noted, although some experimenters report negative results.

Gager[1] in summarizing his investigations states that radium acts under certain conditions as a stimulus to physiological processes, but, if used in too great strength or for too long a period, it may retard development or even kill the plant.

Fabre[2] noted some beneficial effects from emanations, using a concentration of $1\frac{1}{2}$ microcuries[3] for each 2 liters of air, but injury from greater strength.

Stoklasa[4] found that radium emanations promoted germination of seeds and accelerated the growth of plants to a considerable extent. From earlier experiments he has reported increased fixation of nitrogen by bacteria.

In the spring of 1913, through the kindness of the Standard Chemical Company of Pittsburgh the University of Illinois Agricultural Experiment Station was enabled to begin a series of field experiments with radium as a fertilizer or crop stimulant. The company was deeply interested in having the experiments conducted, and the radium salts furnished to us were prepared under the direction of Doctor Otto Brill and Doctor Charles H. Viol, of the radium research laboratory of the Standard Chemical Company, the quality and strength of the preparations being thus assured.

The value of radium is about $100 per milligram and in order that the field investigation might have a direct relation to practical agriculture, the radium was used at three rates of application, costing, respectively, $1, $10 and $100 per acre; or in amounts of .01 milligram, .1 milligram and 1 milligram of radium per acre. If the effect of the application should be marked and permanent, even the initial expense of $100 per acre might be desirable.

The fields selected for these experiments were the north division of Series 200 and the south division of Series 600 of the agronomy plots on the South Farm of the University of Illinois. Each of these fields includes 144 fortieth-acre plots, two rods square, besides some divisions and border strips, making the field sixteen rods wide east and west, and thirty-eight rods long north and south.

On Series 200 and on the west part of Series 600, the radium was applied in a solution of radium barium chloride diluted with distilled water, the check plots receiving the same quantity of distilled water without radium. On the east part of Series 600 solid radium barium sulfates were applied, after diluting by thoroughly mixing and pulverizing with dry soil from the field, the check plot receiving the same weight of soil without radium. The pulverized soil was applied with a force-feed grain drill, and the solutions with an Aspinwall barrel sprayer.

The amount of radio-active substances applied in these tests was purposely made small, in order to avoid any appreciable effect of the substance other than that due to radio-activity. It is conceivable that some effect might be obtained from the application of 100 or 200 pounds per acre of mineral salts. The amount in the case of the heaviest applications was less than five pound of total salts per acre.

On both fields corn was grown in 1913 and soy beans in 1914. Owing to other experimental work involving some variations in planting, only part of Series 600 furnished comparable data in 1913, only twenty-four separate trials being provided. The work of the two years,[5] however, comprised 144 tests with corn and 240 tests with soy beans. Aside

1 *Popular Science Monthly*, Vol. 74, pp. 222–32.

2 *Compt. Rend. Soc. Biol.*, 70, 187, 419.

3 A microcurie is a millionth part of a curie, the unit of measurement for radio-activity, which is the quantity of radium emanation in equilibrium with one gram of radium. In other words, the curie represents the constant or continuous energy of one gram of radium.

4 *Chemiker Zeitung*, Vol. 38 (1914), No. 79, pp. 841–44.

5 For detailed data see Bulletin No. 177, University of Illinois Agricultural Experiment Station.

from the corn grown on Series 200 in 1913, the average results are considered trustworthy.

EFFECT OF RADIUM ON FIELD CROPS

Increase or Decrease per Acre

Radium per Acre, Mgs.		.01		.1		1	
Crops Grown		Gain	Loss	Gain	Loss	Gain	Loss
Corn, ser. 200, 1913, bushels	West	—	1.0	2.6	—	3.9	—
	East	2.3	—	3.0	—	3.5	—
Corn, ser. 600, 1913, bushels	West	.1	—	.8	—	1.7	—
	East	—	.3	—	1.2	—	.6
Soy beans, ser. 200, 1914, bushels	West	—	.5	1.0	—	—	.2
	East	1.4	—	1.9	—	1.1	—
Soy beans, n. half of ser. 600, 1914, bushels	West	—	.2	—	1.1	—	1.5
	East	1.0	—	.5	—	2.2	—
Soy-bean hay, s. half of ser. 600, 1914, lbs.	West	275	—	—	138	—	215
	East	—	13	—	74	42	—

Series 600 possesses an unusually satisfactory degree of uniformity; but on Series 200 there are some topographic variations which influence the rapidity of "run-off" or absorption of rain, and in very dry seasons, with occasional dashing showers, when moisture is a factor of great importance, these variations appear in the crop yields. From April 11 to September 11, a period of five months, the total rainfall in 1913 was only 5.87 inches. Under these adverse conditions, even the average results from Series 200 are not considered trustworthy, notwithstanding the large number of separate trials making the averages. Even from the general averages .01 milligram of radium appears to have decreased the yield by 1 bushel on the west part and to have made 2.3 bushels increase on the east part of the field. Again, increasing the cost of radium from $1 to $10 per acre appears to have increased the yield of corn by 3.6 bushels on the west part and by only .7 bushel on the east part; and the further increase of $90 shows apparent gains of 1.3 bushels on the west and .5 bushel on the east part of this field. Of course no conclusions should be drawn from such discordant plus and minus results.

The results with soy beans on Series 200 in 1914 agree within narrow limits in showing no benefit from the radium applied the year before, the west half of the field giving slightly smaller and the east half slightly larger average yield where radium was added than on the check plots.

On Series 600 the average yields of corn in 1913 were slightly larger with two kernels per hill and slightly smaller with three kernels per hill where radium was applied, but the apparent gains and losses are all well within the experimental error of plot variation, and the general average indicates no effect from the radium. The yields of soy-bean seed on the north half of this field in 1914 likewise reveal no influence of radium, all rates of application indicating as an average slight decreases for radium on the west side and slight increases on the east side of the field. With the soy-bean hay the six general averages show no effect from radium, four results being slightly below the checks and the other two slightly above.

Thus from the two years' work we have six trustworthy average results with corn, three "for" and three "against" radium, and we have eighteen averages with soy beans, nine "for" and nine "against" radium. In all of these trials the average variation from the checks is so slight and so evenly distributed, "for" and "against," as to lead only to the conclusion that radium applied at a cost of $1, $10 or $100 per acre has produced no effect upon the crop yields either the first or second season.

Radium, with all its wonderful energy, is found upon careful analysis of the known facts, to afford no foundation for reasonable expectation of increased crop yields, when financial possibilities are considered. The rate of application mentioned by Fabre, on the basis of 1½ microcuries for each space four inches square and eight inches high, would cost about $58,800 per acre at present prices for radium.

It is true that the total ultimate energy developed in 1,760 years from 1 pound of radium will be equivalent to 35,000 horse-power days of 24 hours each; but when the time is reduced to 100 days of good crop-growing weather, and the amount of radium reduced to 10 milligrams, or to a cost of $1,000 per acre, then the energy emitted from the radium

for the possible benefit of an acre of corn during the crop season would be equivalent to 1 horse-power for 22 seconds; and the heat evolved by $1,000 worth of radium on an acre of land in 100 days would be less than the heat received from the sun on one square foot in 30 seconds.

CYRIL G. HOPKINS,
WARD H. SACHS
UNIVERSITY OF ILLINOIS

SPECIAL ARTICLES

NEW REPTILES FROM THE TRIAS OF ARIZONA AND NEW MEXICO

BEGINNING the later part of March, 1914, the University of Wisconsin paleontological expedition spent two months in Arizona and New Mexico collecting Triassic vertebrates. The time was divided chiefly between two localities, Wingate, New Mexico, nine miles east of Gallup, and along the Little Colorado River some fifty miles northeast of Flagstaff, Arizona. In both localities material was collected which should add substantially to our knowledge of the Triassic vertebrate faunas of the west.

Conspicuous among the collections are Phytosaur remains of various types. One nearly complete skull, apparently the largest yet discovered, will probably prove to be a new form.

One of the most interesting finds from the Wingate region is that of a nearly complete pelvic girdle of distinctive form. The sacrum consists of two closely united vertebræ with moderately biconcave centra. The neural arches are massive and are surmounted by stout, comparatively short spines with considerably expanded tops. The sacral ribs unite broadly with the arch and centrum, each rib being supported by a single vertebra. Distally the ribs are greatly expanded in an antero-posterior direction and are considerably thickened below and apparently down curved along the inner side of the ilium.

The upper portion of the ilium is expanded both laterally and in an antero-posterior direction into a broad, horizontal shelf. The ischia meet along the median line in a trough-like union that extends back in a horizontal tongue-shaped process. The pubes take a comparatively small part in the floor of the pelvic opening as the lower anterior portion of these elements extends directly down in a broad plate-like expansion at right angles to the vertebral column. The lower outer corner of the pubic expansion is swollen into a foot-like process, possibly to bear a portion of the weight of the creature when at rest.

All three elements enter the imperforate acetabulum in a firm union. The acetabulum is large and deeply concave and set off by a prominent raised boundary. It is directed out and down and considerably back. The girdle measures about 450 mm. from the top of the sacral spines to the lower border of the plate-like expansion of the pubis. The greatest width, at the lateral expansion of the upper portion of the ilia, is approximately 370 mm.

The massive construction of the girdle has suggested the name *Acompsosaurus wingatensis* for this new form. It is to be hoped that other material in the collections will add a knowledge of other parts of the skeleton. Figures and a more complete description of *Acompsosaurus wingatensis* will follow in another place.

MAURICE G. MEHL
UNIVERSITY OF WISCONSIN

SOCIETIES AND ACADEMIES

THE BIOLOGICAL SOCIETY OF WASHINGTON

THE 539th meeting of the society was held in the Assembly Hall of the Cosmos Club, Saturday, April 3, 1915, called to order by President Bartsch at 8 P.M., with 65 persons present.

On recommendation of the council, Mr. Ben Miller was elected to active membership.

Under heading Brief Notes, Dr. L. O. Howard called attention to a wasps' nest he had lately seen which was marked by a conspicuous blue streak. In making this nest the wasps had evidently made the blue streaked part out of a blue building paper, instead of making their pulp from the natural wood. Messrs. Bartsch and Lyon referred to the red-headed woodpeckers in the grounds of Freedmen's Hospital, stating that a few birds had remained during the winter of 1914–15, though none had wintered during 1913–1914. The species is abundant in the hospital grounds this spring. Messrs. Bartsch and Bailey

commented upon the scratching of the gray squirrels in the city parks, which Mr. Bailey said was due to infestation with fleas from their winter boxes. Suitable insect powder placed in the boxes would drive out the fleas, but was not relished by the squirrels.

The first paper on the regular program was by Dr. A. H. Wright, of Cornell University, "The Snakes and Lizards of Okefenokee Swamp." Dr. Wright said:

Seven snakes of the dry open sandy fields or pine forests of southeastern U. S. were absent on the Okefenokee Swamp islands. None of the truly Floridan ophidians and saurians were represented. Some forms occurred on the outskirts of the swamp but were wholly wanting within the swamp. The 21 species of snakes and 6 lizards were very variable in scutellation and coloration. Whether the restricted quarters and the incessant warfare and struggle for place caused the wide range of variation is not yet answerable. We had expected to find fixed peculiar stable races or subspecies because of the isolated nature of some of the islands, but segregation has not yet placed a local stamp on any of the reptilian forms. The swamp is the common source of the Atlantic coastal stream, the St. Mary's, and the Gulf affluent, the Suwannee. This factor may have had its influence on the turtles and possibly on the snakes and lizards. The swamp does not appear to be a barrier or boundary line between two decided faunal areas. It is rather a melting pot for many of the supposed cardinal characters of distinction in snakes and lizards.

Some of the interesting systematic observations are: the nontrustworthiness of the temporal scutellation and coloration in the *Elaphe* group; the need of further study in the *Tropidonotus fasciatus* assemblage; the presence of the *Osceola elapsoidea* and the *Lampropeltis doliatus coccineus* characters in one and the same specimen; the reduction of *Diadophis amabilis stictogenys* to *D. punctatus;* the non-recognition of *Ophisaurus ventralis compressus;* the presence of white-bellied adults and young of *Farancia;* the possibility of *Heterodon niger* as an end phase of coloration and a query as to the loss of the azygous in *Heterodon browni;* the overlapping in scale rows and ocular formulæ in *Storeria occipitomaculata* and *S. dekayi;* the fact that no two heads of the *Sceloporus undulatus* specimens had the same plate arrangement; and the unreliability of the mental characters in *Plestiodon,* our specimens of *P. quinquelineatus* falling into two of Cope's major groups, if determined on mental scutellation.

Dr. Wright's paper was illustrated by lantern slides showing views of the swamp, of its reptile inhabitants, and of the variations found in certain of the species. His communication was discussed by the chair and Messrs. Wm. Palmer and Hugh Smith.

The second and last paper of the program was by Dr. Arthur A. Allen, of Cornell University, "The Birds of a Cat-tail Marsh."

Observations on the food, nesting habits and structure of marsh birds showing the limitations of specialized species as to food, distribution and power of adaptability and the dominance of generalized forms were made.

Specialization in birds goes hand in hand with a high development of the instincts, but with a low degree of intelligence and little adaptability. Generalization of structure, on the other hand, occurs with a weaker development of the instincts, greater intelligence and greater adaptability. The generalized, adaptable species persist through the ages, while the specialized, non-adaptable are first to go. This is seen in the birds of a cat-tail marsh.

Seven stages are recognized in the formation of a marsh, represented in the mature marsh by zones of typical vegetation or plant associations, these associations following one another in regular succession. Similar associations and successions can be recognized among the birds if we group them according to their nesting range in the marsh. Most species are not confined to one association, although reaching their maximum of abundance in it. The generalized, adaptable species have the widest range.

The various associations with their typical birds follow:

I. The Open-water Association; important in supplying forage, but with n nesting birds.

II. The Shoreline Association, with the pied-billed grebe, a specialized non-adaptable species.

III. The Cat-tail Association, with the least bittern, coot, Florida gallinule, Virginia rail, Sora rail and red-winged blackbird, finding optimum conditions.

IV. The Sedge Association, with the long-billed marsh wren, bittern, swamp sparrow, short-billed marsh wren, and marsh hawk.

V. The Grass Association, with the song sparrow and Maryland yellowthroat.

VI. The Alder-Willow Association, with the green heron and alder flycatcher.

VII. The Maple-Elm Association, with the black-crowned night heron, and great blue heron of the marsh birds and a great variety woodland species.

Of all these species the one most generalized in habit and structure is the red-winged blackbird. It, too, is the most adaptable and is the dominant species in the marsh.

Dr. Allen's paper was illustrated by numerous lantern slides from photographs of the marsh, its bird inhabitants, and their homes, and by motion pictures of the least bittern and of the canvas-back and other ducks.

Dr. Allen's paper was discussed by Dr. L. O. Howard.

The society adjourned at 10.15 P.M.

M. W. Lyon, Jr.,
Recording Secretary

SCIENCE

FRIDAY, MAY 21, 1915

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

REMINISCENCES OF THE WOODS HOLE LABORATORY OF THE BUREAU OF FISHERIES, 1882–89[1]

ON February 9, 1871, a law was passed by Congress which directed the President to appoint a man of approved scientific and practical knowledge of fish and fisheries, to be chosen from among the civil officers of the government, who was to serve as U. S. Commissioner of Fish and Fisheries without additional salary.

This act virtually defined Spencer F. Baird, secretary of the Smithsonian Institution, who thereupon was appointed commissioner by the President. The commissioner was clothed with unusual powers; for the act instructed the heads of the various executive departments to render the commissioner such assistance as might lie in their power. Frequent acknowledgments of the cooperation of the departments of the treasury, war, interior and navy are found in the earlier reports of the Fish Commission.

The immediate problem before the commissioner was: An inquiry into the decrease of food fishes. It is interesting to note that Professor Baird chose Woods Hole as the place for beginning research on this problem. That was in the summer of 1871. Those associated with him were Professors A. E. Verrill, Theodore N. Gill and Sydney I. Smith.

The headquarters in 1872 were at Eastport, Maine; in 1873 at Portland, Maine; in 1874 at Noank, Connecticut; in 1875 again at Woods Hole. During the year

[1] A lecture delivered before the Marine Biological Laboratory, Woods Hole, Mass., August 7, 1914.

1876 no active field operations were carried on by Professor Baird on account of duties connected with the superintendency of the government exhibit at Philadelphia. In the report for 1876, however, the following statement is made:

> The laboratory at Woods Hole was opened . . . for investigators, to whom every facility and assistance was furnished by Vinal N. Edwards in charge of the station.

The first part of the summer of 1877 was spent at Salem, Mass. In August the party proceeded to Halifax, N. S., where a second station for the summer was formed. Among the assistants of Professor Verrill that year was E. B. Wilson. (It is needless to inform this audience that E. B. Wilson has since been promoted.) In 1878 the laboratory was on Fort Hill at the mouth of Gloucester Harbor; in 1879 at Provincetown, Mass., and in 1880 at Newport, R. I. In 1881 Woods Hole was again chosen as the center of scientific operations. In the report for that year Professor Baird speaks of the advantages of the place as a permanent sea-coast station of the U. S. Fish Commission. In the report for 1882 the reasons for choosing Woods Hole as a permanent station are given. After speaking of the experience at Gloucester the report continues:

> A totally different condition of things was found at Woods Hole where the water is exceptionally pure and free from sediment, and where a strong tide rushing through the Woods Hole passage keeps the water in a state of healthy oxygenation specially favorable for biological research of every kind and description. The entire absence of sewage owing to the remoteness of large towns, as well as the absence of large rivers tending to reduce the salinity of the water, constituted a strong argument in its favor, and this station was finally fixed upon for the purpose in question.

In the report for 1875, published in 1878, one finds the spelling of the name of the station changed from Woods Hole to Woods Holl. This change was made in conformity with a similar change made by the Post Office Department. An ingenious argument for this unusual way of spelling hole will be found in a small pamphlet written by the late Joseph Fay. It should be stated, in justice to the author of the pamphlet, that his contention was that the word in question was really the Norwegian word *holl*, meaning a hill, but pronounced hole.

In this connection it is proper to mention the fact that this same Joseph Fay gave to the U. S. government the waterfront extending from what is now the property of the Marine Biological Laboratory to what is now called Penzance, but then was without a name, if one will except the obvious epithets which were liberally applied to the locality by the residents of Great Harbor whenever the wind was from the northwest, for there was situated a large fertilizer establishment, known locally as the "Guano Works." Among material collected at Woods Hole in 1882, I still have a considerable number of goose-barnacles which I scraped from an Italian bark, 90 days out from the Mediterranean, then tied up at the wharf of the "Guano Works" and unlading her cargo of sulphur.

Prior to 1877 the tug *Blue Light* was detailed by the Navy for the use of the Fish Commission. A larger tug, the *Speedwell*, was detailed in 1877. In the year 1880 the *Fish Hawk*, which had just been built, was used in exploring the Gulf Stream and its fauna, especially in connection with the distribution of the tile-fish. In 1883 the *Albatross*, a ship especially designed for deep-sea work, was completed and placed in commission.

Professor Baird early inaugurated the policy of naming a vessel that was propelled by its own power for some bird. A sailing-vessel was given the name of a water mammal, while rowboats were given the names

of fish. With the installation of auxiliary motors in such craft as the *Grampus* and *Dolphin* the taxonomy of the Fish Commission's flotilla is not without its difficulties.

When Professor Baird was laying his plans for a permanent laboratory he was in much doubt as to his ability to induce Congress to make an appropriation for such purpose. Assured of a location for the laboratory, through the public spirit of Joseph Fay, he conceived the idea of having universities and colleges cooperate in the building of a laboratory. To this end he prepared articles of agreement whereby an institution by contributing the sum of one thousand dollars would have the right in perpetuity to the use of a table in the laboratory. This offer was open for but a short time, as Congress, having had experimental proof of the administrative ability and probity of Professor Baird, made the necessary appropriation for the construction of the laboratory. Before the offer was withdrawn, Professor Alexander Agassiz had subscribed for a number of tables, four, I think, for the use of Harvard University. My recollection is that one table was subscribed for by Princeton, one by Williams, and one by some other institution. It is largely owing to this plan that a succession of graduate students has occupied tables in the laboratory of the Fish Commission since 1885. These students brought with them new ideas and methods and inspiration that have been important factors in the usefulness of the laboratory.

Upon the death of Professor Baird, in 1887, G. Brown Goode was made commissioner pro tempore. He, indeed, was the logical successor of Professor Baird, but preferred to remain at the head of the National Museum. In the meantime the law had been changed, so far as to make the office of commissioner a salaried office. Colonel Marshall McDonald was appointed commissioner in 1888. He served until his death in 1895. Captain J. J. Brice of the Navy was made commissioner in 1896, Mr. Herbert A. Gill being acting commissioner in the interval. Captain Brice served until 1898, when he was succeeded by George M. Bowers, who served for nearly as long a term as that of Professor Baird's. During Mr. Bowers's term of office the commission ceased to be independent. It became a bureau, first in the Department of Commerce and Labor, then in the Department of Commerce. In 1913 Dr. Hugh M. Smith, long associated with the commission, and for some years deputy commissioner, succeeded Commissioner Bowers, and is the present commissioner.

In all the time from 1871 to the present, with the exception of the brief administration of Captain Brice, every encouragement has been given to scientific investigation at the Woods Hole Laboratory of the Fish Commission. Of the laboratory during the administration of Captain Brice I have no personal knowledge. I have been informed, however, that then, for a time, at least, scientific work was virtually suspended, and would have ceased entirely but for the vigorous insistence of Professor Alexander Agassiz on the right of Harvard University to occupy tables in the laboratory. Thanks, therefore, to these compacts, which, I think, Professor Baird somewhat regretted had been entered into, the work of scientific investigation at the Woods Hole Laboratory of the Fish Commission has not been seriously interrupted from its inception under Professor Baird to the present time.

Prior to 1885 the laboratory was on the lighthouse wharf on Little Harbor in the two-story building which had been refitted, the second story added, with outside stairs on the north side. Professor Baird lived in the house which stands just east of the one occupied by Miss Sarah Fay. As I re-

member the house then it had a good-sized porch in front. The offices of the clerical force of the commission were in a house known as the Gardiner house, which stood about where the entrance to the rose garden now is. This house has since been removed. The house occupied by Professor Baird also accommodated the mess, which was made up of the scientific workers and the clerical force. The various members of the party roomed at private houses in the village. For example, in the summers of 1882, 1883 and a part of 1884, four of us younger men had rooms on the third floor of what was then, and still is, the rectory. From the windows of these rooms are to be had some of the most charming views of these beautiful shores.

The residence building was first occupied early in August, 1884. It then accommodated Professor Baird's family, the scientific staff and the office force. The dining-room easily accommodated the entire company, about 30, which constituted a real family, of which Professor Baird was the head. He and his wife and daughter, and some of the older members of the scientific corps, with their wives, occupied one table, the other scientific workers filled another table, and the clerical force a third. The parlor of the residence made a general meeting-place where all the members of the family were accustomed to assemble in the evenings. Although the habit of working in the laboratory at night still continued, members of the laboratory force were in frequent attendance at these family gatherings. In the summer of 1886 we rented a piano and installed it in the parlor, where some pleasant hours were spent in singing, and, on a few occasions, others were invited in and there was a little dancing.

Work on the new laboratory building was in progress during the summer of 1884. A picture which hangs on the south wall of the porch room of the residence gives a view of the locality where the Fish Commission buildings now stand, as it appeared in 1882. During the dredging operations that preceded the construction of the sea wall that encloses the basins we were frequently detailed to make collections of the mud-inhabiting forms that were brought up by the dredge.

The laboratory in 1882 was, as has been stated, on the lighthouse wharf on Little Harbor. Ordinarily the day's work began before 9 o'clock and continued until 10 or 11 o'clock at night. As Professor Verrill's assistant my work in 1882 and 1883 was especially directed to the group of Annelids. Later I was promoted to investigate the ancient and, to some minds, dishonorable, order of Cestodes and their kindred.

In those years there was not much systematic collecting done along shore and in shallow water, except for certain groups and localities. A good deal of time was taken up in the collection and study of surface material, but the chief interest centered about the trips of the *Fish Hawk* to the Gulf Stream. There were other shorter trips for the purpose of exploring some shallow-water localities that were very full of interest to a beginner. The first trip which I made was one to the northward where the dredging operations began off Chatham and continued to Provincetown. It was on this trip that I saw for the first time, in a living state, some particularly large sea-anemones, and the many-armed serpent-star *Astrophyton*. At Provincetown there was at that time an establishment on the point where whale oil was tried out, the whales being taken offshore and brought in to the try-works. There was a vast accumulation of vertebræ, ribs and baleen there, and the younger members of the party took advantage of the opportunity to make private collections, which Captain

Tanner very kindly allowed us to bring back on the ship. The odor thus transferred to the hold of the *Fish Hawk,* while in itself not small, we could assure the captain would not be missed on the point, where it was massive, corporeal and all-pervading.

Almost daily collections were made of surface material. Trips for this purpose were made in the Fish Commission launch, *Cygnet,* D. H. Cleveland, captain, and W. H. Lynch, engineer. Now and then when trips were in the daytime we contrived to have a race with the Forbes launch, *Coryell,* at which times, if the energy with which Lynch shoveled coal could have been transferred directly to the machinery that actuated our propeller, we should have easily won. As it was, unless my memory is at fault, the *Coryell* usually got the better of us.

Two or three times a week collections were made in the evening, beginning just after dark. A favorite place for making these evening collections was in the "hole," where the launch would be made fast to the nun buoy, and for an hour or more towing-nets were used. The material thus collected was then taken back to the laboratory, where it was immediately examined. In this way much information was obtained of the nature, times, seasons, stages of development and habits of the life at and near the surface. I do not remember hearing in those years the word plankton used. Possibly a more tolerant interest might be awakened in a modern audience in these old-time investigations if this paragraph had been headed with the cabalistic legend: Plankton studies.

In 1882 dredging on the outer continental slope was still being vigorously carried on, most of it in depths ranging from 100 to 400 fathoms. Trips to this locality were usually called Gulf Stream trips. The great abundance of living things brought up by the trawl from this under-sea edge of the continent was still yielding many new and interesting forms, and, since it was important that the material be cared for promptly, three or four of the younger men were always detailed for this work. Professor Verrill himself did not go on these trips, the motion of the ship quickly incapacitating him for work. Indeed, any one who can endure the motion of the *Fish Hawk* for 24 hours without experiencing unpleasant sensations can qualify as an able seaman, at least as far as immunity from sea-sickness goes. Our trips to the Gulf Stream were carried out in this wise: The precise time of departure was not set until a short time before starting. This was because the *Fish Hawk,* having been designed as a kind of wandering fish hatchery whose field of operation was to be limited largely to such bodies of water as Chesapeake Bay, was not then and is not now regarded as a vessel that could safely weather a severe storm. It was Professor Baird's custom, therefore, before sending the *Fish Hawk* on an outside trip, to get a special bulletin from the weather bureau saying that no atmospheric disturbances were indicated for the North Atlantic coast for the next forty-eight hours. Favorable conditions prevailing, we were then notified, sometimes but an hour or two, or even less, before starting, that we were expected to make a trip to the Gulf Stream. The usual time for starting was 5 P.M. We steamed out all night, and upon the following morning, having now arrived at the outer slope, began dredging. As a rule the trawl was overboard by 5 o'clock; the first haul was consequently made before breakfast. My recollection of these days are of hours of not altogether unalloyed pleasure. To this day the smell of material brought fresh from the bottom of the sea awakes memories that

I would fain let slumber. The material which but a short time before had been on the bottom at a temperature but little above the freezing point was unpleasantly cold to handle. Then there was the ever-present discomfort caused by the rolling of the vessel, accentuated to a stomach-racking degree by the motion communicated to the vessel when the dredging was in operation. Under such conditions it should not be a matter of wonder if from time to time the most zealous of naturalists turned away from the large seive, into which the material from the trawl was emptied, with feelings akin to those experienced by the fishes just before they lost consciousness as they were being hurried from the bottom. These fishes came to the surface with either swim-bladder or stomach protruding from their mouths, and their eyes starting from their sockets. Such phenomena are due to the enormous release of pressure experienced in being in a few minutes transferred from the bottom to the surface, a difference approximating 50 pounds for each one hundred feet, or 300 pounds per square inch for a depth of one hundred fathoms.

The forms brought from the bottom on the borders of the Gulf Stream, were so varied and so different from those found along shore or at moderate depths that, until they had been seen repeatedly, they caused the disturbing motions of the *Fish Hawk* for the time to be forgotten. For example, an annelid which lives in a tube constructed from its own bodily secretions early attracted my attention. The tube had the appearance of quill; when burned it gave the same odor as burning quill, and, when cut into the shape of a pen, could be used for writing the worm's name. Another was an interesting case of symbiosis, or life-partnership, that had been made familiar to those of us who had listened to Professor Verrill's lectures. Here it was seen in the living condition, a hermit crab having its home in a living house, that grew as the crab grew, and consisting of a colony of sea-anemones. Close examination would usually show that the sea-anemones had originally established themselves on the shell of a mollusk in which the hermit crab was living. The cœnosarc common to the anemone colony not only grew entirely over the shell, but continued the lip of the shell with enlarged gap so that the crab did not need to seek a new and larger shell in subsequent molts. Furthermore, the advantage of this partnership is mutual. On the one hand the crab is provided with a house which adjusts itself to its needs and, with its frieze of tentacles, armed with nettle-like defensive organs, gives him a measure of protection from his enemies. On the other hand, the anemone is carried about by its active partner and is thus afforded a much more varied experience than it would have if growing on a non-motile object. Moreover, the crab, being a greedy feeder, very unlike Chaucer's nun, who, we are told, "let no morsels from her lippes fall," allows many fragments of his meals to float off in the surrounding water, is thus, while eating, doubtless often encompassed by a cloud of crumbs which are as manna to the colony of polyps which thus become literally commensals or true table companions. Such matters are, of course, familiar to students and teachers of zoology, but may not be so familiar to those whose biological training has proceeded along different lines. An interesting feature about this case of commensalism is that, while several hundred specimens were collected in the expeditions of the *Fish Hawk* to the Gulf Stream, these two species were always found associated as commensals. In other words, this particular species of hermit crab was not found except as a commensal of this particular species of sea-

anemone, and this particular sea-anemone was not seen except as a commensal of this particular species of hermit crab. Other cases of commensalism between sea-anemones and crabs were encountered, but none in which the commensals were so faithful to each other as in this.

The material of a haul having been cared for, some of it assorted, labeled and placed in proper preserving fluid, some of it kept in sea-water to be brought alive to the laboratory, we quickly relapsed into that condition of indifference to all things, past, present and to come, which characterizes alike the sea-sick and the aspirants to Nirvana. From this apathetic state we aroused less and less completely as the day wore on. On one or two trying occasions when a heavy swell rocked the *Fish Hawk* in its glassy cradle, much of the material in the last haul, in spite of its great value from the point of view of those who desired an accurate knowledge of the life on the ocean floor, was huddled together and brought back to the laboratory in much the same condition in which it was scraped from the bottom by the trawl.

Before the trawl was put overboard a sounding was made. This was done by means of an ingenious machine invented by Captain Sigsbee of the navy. Instead of the hempen cord of the older machines fine piano wire was employed. A thermometer was also sent down with the sounding lead, the case in which it was enclosed being fastened securely at the lower end, while the upper end was held to the wire by a detachable clamp which was loosed by a lead traveler sent down the wire. This tripped the thermometer, which, in turning over, broke the column of mercury in a bend of the tube, so that the mercury in the filiform portion of the tube remained and could be read in the reversed instrument when it reached the surface. Specimens of the bottom were also obtained. Thus each sounding yielded data of depth, temperature and character of the bottom. Now and then temperatures at different depths in the same locality were taken. The bottom was largely a soft foraminiferal ooze into which the trawl sank, the net sometimes bringing up a large mass of mud, in spite of its having traversed a hundred fathoms or more of clean sea-water on its way to the surface. Occasionally a boulder of fair size was captured, and on more than one occasion the load was too heavy for the net. What came to the surface then was a broken net with, at most, a few small starfishes and serpent-stars clinging to its sides. At such times the comments of Captain Tanner resembled some of the more lurid passages in the novels of Captain Maryatt.

Most of the dredging work of the *Fish Hawk* on the Gulf Stream was done with a beam trawl. The lower end of the net was kept on the bottom by means of leaden weights, while the net itself was buoyed up with hollow balls of thick glass. Sometimes these balls, which were empty when they were started down, came to the surface with water inside. This appears to be due to the extreme pressure which forced water through minute openings in the glass.

In addition to the bottom work some attention was given to the collecting of surface material by means of towing nets and dip nets. Specimens of the Portuguese man-of-war and other Siphonophora were frequently taken as well as *Hippocampus* and various other forms found in the floating gulf-weed. Sharks also were sometimes taken, and, on one trip I remember, three or four porpoises were harpooned. This latter, however, was rather by way of diversion and did not enter into the more serious work of the trips.

About sundown the dredging was discontinued; the ship's course was laid for

Gay Head light, and the thump, thump of the engines began, to keep up all night. On the following morning, soon after sunrise, we would sight Nomansland or Gay Head, and about 9 o'clock were tied up at the wharf in Great Harbor, which, as I remember, was just west of the Luscomb wharf.

Sometimes the fair-weather forecast did not hold good for the whole trip. That meant an uneasy time for Captain Tanner, who, it was said by other officers and by the crew, never slept from the time the *Fish Hawk* put out to sea until she was safe in harbor. Of one of these return trips I have a vivid recollection. With little provocation the *Fish Hawk*, not then provided with a bilge keel, could get up a 45° roll. On this occasion soon after we turned in we had an exhibition of rolling and pitching and various combinations of these severally trying motions that far outdid any former exhibitions of similar nature. Now and then the twin screws, prophetic of the air craft of the present day, were whirling in air, while on board there was a constant rattling and banging, creaking and slamming, with an occasional crash of breaking glass that kept us awake but, so far as I remember, did not cause us any alarm. We did not know much about the sea-going qualifications of the *Fish Hawk*, while we had an extravagant confidence in the ability and caution of the captain.

When we reached port on this trip Captain Tanner put in circulation a new story. In order to understand the point of the story it is necessary first to explain that, just as now the title of a scientific worker in Woods Hole is doctor—so much so indeed that one readily understands why a little girl a few years ago brought word upstairs to her mother that Dr. Boles, the carpenter, was below—so, in the 80's, the title of professor was similarly employed. "The Professor" always, and to all persons, meant Professor Baird. Otherwise the title of professor was bestowed with great liberality and impartiality. Indeed we young assistants were called professors by the crew of the *Fish Hawk* as cheerfully and naturally as the same persons would have given the title to an instructor in the art of self-defense. It so happened on this trip that there were some worthies on board who occupied the spare staterooms, and mattresses were spread in the ward room for the assistants. Captain Tanner said that when it came on to blow he sent his servant, George, below to see if everything had been made secure. When he returned the captain asked: "Well, George, is everything clewed up tight?" "Yas, sah." "You're sure that all's been made snug?" "Yas, sah." "Nothing loose?" "No, sah, 'scusin of a few professors adrift on de ward-room flo'."

On a number of the trips made to the Gulf Stream in 1882 trawl lines and bait were taken along for the purpose of fishing for the tile-fish, whose destruction in enormous numbers had been reported by incoming vessels in the spring of that year. These vessels reported that they had seen countless millions of fish in a dead or dying condition covering thousands of square miles of the sea. The tile-fish (*Lophilatilus chamæleonticeps*) was first taken in 1879. It is a bottom fish with habits much like the cod, and it occurred in vast numbers in the waters bordering the Gulf Stream between Hatteras and Nantucket previous to the season of 1882.[2]

Professor Baird had hoped that profitable fisheries for this species might be opened up, and was very anxious to have specimens secured to prove that the species was still extant. I remember a remark that Captain Chester made as he came alongside

[2] U. S. Fish Com. Report for 1882, pp. 237–94.

the ship on our first trip to the tile-fish grounds, after underrunning the line that had been set for several hours. There were a considerable number of fish of various kinds in the bottom of his boat which he had taken from the line. Some one sung out from the ship asking him if he had taken any tile-fish. His reply was: "Not a lophilatilus, not a chamæleonticeps!" In fact no tile-fish were taken until July, 1899. They were taken again in July, 1900. The hoped-for fisheries for the tile-fish have not yet been realized.

The *Albatross* started on her first trip from Woods Hole July 16, 1883. The trip lasted, as I remembered it, five days. It was my good fortune to be one of the number assigned to this trip. In attempting to review the events of this trip I find that my ability to recall details is limited to a not large number of incidents which rise in my memory like pictures. Life on ship board is somewhat monotonous at best, and when one experienced an undertone of discomfort, there follows the natural tendency to dismiss all recollection of it from the mind.

One experience, however, was so unique, and, fortunately, not associated with feelings of discomfort, that I have often lived it over in my memory. That was when the first haul was made from the deep sea. A depth, as I remember it, of 1,400 fathoms, or nearly 1.6 miles, was shown by the sounding that was made just before the trawl was put overboard. As the dredging operations of the *Fish Hawk* had been limited to localities where the maximum depth was less than half this depth, this was the first experience of any one on board with really deep-sea dredging. Of this event the picture which I carry in my memory is a moving one of perhaps a little more than a quarter of an hour's duration, beginning a few minutes before the trawl appeared and ending after we had spent a few minutes in overhauling the material. The trawl had been over several hours. I have not verified my impressions, but I think it was possibly as much as six hours. When the indicator showed that the trawl was within a few fathoms of the surface every one began to peer down into the transparent water to catch sight of the messenger that had been on such a strange voyage of discovery. It was long past sunset and quite dark, but the scene was brilliantly lighted by electricity. A strong arc-light suspended over the water made sufficient illumination to reveal a school of flying squid pumping themselves about in the water. The light penetrated to sufficient depth to enable one to trace the wire cable far down until it was lost in the darkness below. For some reason, I do not know why, I glanced around. What I saw and remember would, I think, make a worthy theme for a great painting. In the foreground were the naval officers in their trim uniforms; near them the little band of investigators in their nondescript but not unpicturesque attire. Grouped on the forecastle was almost the entire ship's crew, the white trappings of the sailors standing out bravely under the rays of the powerful electric light. Above, below and around about, darkness. The picture was given the needed motif by the approaching trawl upon which all eyes, but my own for a brief interval, were centered. I find myself still as a somewhat detached spectator recalling this scene, and think of this little hemisphere of light in the general gloom that shrouded the great expanse as symbolic of the light of science in the world, which is shining not only to reveal the things that may be seen, but striving to illumine the depths and thus bring to the surface a knowledge of things that lie deeply hidden. This scene lasted but a short time. Pres-

ently we could discern, far down in the transparent waters, a formless thing that quickly took shape, and then the trawl was hauled above the surface, the boom swung in, the net emptied into the great sieve, and we had our first view of living examples of the abyssal fauna. Those forms that lay in the sieve had, only an hour or two before, been resting on the ocean floor where their ancestors had lain undisturbed through the ages of the past with no traditions to affright them by visions of some mysterious being reaching down to snatch the dwellers of the abyss to the unknown regions above.

We had become familiar with the rich and varied fauna of the continental slope, and some of the party had had much experience in dredging in depths of as much as 500 fathoms, but among this material, not large in the mass, were forms that at first no one could assign even to a probable phylum. For example there were a half dozen or more curious-looking objects, not unlike in shape and size to an ordinary five-cent loaf of bread, perhaps a little flatter, and in color and consistency resembling the compound ascidian known as sea-pork. When these objects were brought to the attention of the mollusk specialist he would have nothing to do with them, saying that they were ascidians, or, possibly, worms. The annelid specialist passed them by. It was really not until some of these puzzling creatures had been lying for some time in a tub of sea-water that they were seen to be holothurians, sea-cucumbers of unusual appearance plucked from the abyss. Details of this deep-sea fauna may be obtained from the published reports of the Fish Commission. A strange world was opened up to the imagination by these creatures from the depths: Fish with eyes living in those regions whither the light of day can not penetrate! Whence comes the light which the presence of organs of sight implies? Gorgonia corals, slender and fragile and as delicate as the finest grasses of autumn, shining in shadow with a brilliant phosphorescent light, suggest that if we could see this ocean floor, we would see it dimly illuminated by the phosphorescence of its living denizens, among them groves of gorgonians, motionless in the currentless water and shining with a light literally not seen on sea or land.

I propose now to record brief memory sketches of some of those who were associated with the Fish Commission at the Woods Hole laboratory in 1882 and the years immediately succeeding.

SPENCER FULLERTON BAIRD

Information regarding the life and works of this great American can be had from the published accounts. My purpose here is simply to record a few personal recollections.

I first met Professor Baird in the summer of 1882 when I came to Woods Hole as an assistant of Professor Verrill. About the first thing he said to me was to ask what particular field of zoology I was interested in. By this question I can see now two striking characteristics of Professor Baird's mind: First, his interest in young men who were inclined to the study of nature, and, second, his conviction that such study was best begun by becoming familiar with some particular group of animals. He was then about 60 years of age but looked older than his years. He was a large man, probably fully six feet in height, and possessed of a powerful frame. He stooped slightly, his movements were rather slow and his manner deliberate. His hair and beard were becoming gray. He had a kindly smile, a genial but quiet manner, and a bearing which might not improperly be called patriarchal. He had a wholesome sense of humor,

and was not unacquainted with some of the lighter literature of the day. He read with zest, as many of us did, Rider Haggard's "King Solomon's Mines," and was so much interested in Mrs. Burnett's "Little Lord Fauntleroy," which came out in serial form in *St. Nicholas,* to which he was a subscriber, that he asked the author's husband whether the story had been completed, or whether Mrs. Burnett was supplying copy to the magazine month by month. He was much relieved when told that the manuscript for the entire story had been given to the publishers, since he could now go on with the reading without fearing that some calamity might happen to the author that would prevent her finishing the story. He gave the impression of being one who had succeeded in establishing entire control over himself. I never saw him roused out of his habitual serenity but once. That was when a collecting expedition for a special purpose was being delayed in its starting because the commander of the *Lookout* wanted to finish a game of tennis he was playing on the grounds near the Dexter House. (The *Lookout* was a steam-yacht used by Major Ferguson, the assistant commissioner.) When it was reported to Professor Baird that the expedition was being delayed he left his office and walked at a very rapid pace down toward the laboratory on Little Harbor. The commander of the *Lookout,* sighting Professor Baird bearing down upon him under full steam, abruptly suspended his game and a few minutes later the *Lookout* was under way.

Professor Baird's knowledge of living things, especially of fishes and birds, was extensive, exact and detailed. He belonged to the older school of naturalists whose view of nature was bounded by no narrow horizon. Unfortunately for him and for science his later years were encumbered by administrative details which, although he attended to them apparently without worry, were often perplexing, always time-consuming, and grew in volume with the years. As secretary of the Smithsonian Institution and as commissioner of fish and fisheries his administrative burdens were very great. His nature was such that he could not easily shift burdens to other shoulders. As a consequence of all this he suffered the penalties that follow long hours at his desk substituted for a life that had been formerly in good part spent in the open.

In the interval between the summers of 1886 and 1887 his health failed, and in August, 1887, he died in the residence building into which he and his immediate family and the greater family making up the commission force had moved but three years before.

The funeral services were read by the rector of the Episcopal Church of Woods Hole. To the prescribed church service were added two of the beatitudes which appeared to those who had been associated with him most intimately to reflect the high points of his character. They were the ones which pronounce blessings on the peace-makers, and on those who are pure in heart.

Professors A. E. Verrill and Sydney I. Smith are best known to Woods Hole workers for their voluminous and invaluable report on the "Invertebrate Animals of Vineyard Sound and Adjacent Waters." They were alike in that they were zoologists of unflagging zeal. In all other particulars they were unlike and good-naturedly antipathetic. The one was unemotional, dogged, and, to those who did not know him well, seemingly, at times, crusty. The other was quick, vivacious, open and frank in his manner at all times and to all persons. They invariably took opposite sides of any question that came up for discussion, whether it was scientific, political,

theological or philosophical. The only adverse criticism that I ever heard passed upon their use of time was that they often wasted it in argument over questions which, however they might be settled, if they ever were settled, would not advance human knowledge appreciably, or improve human practise materially. It must be remembered, however, that they were both prodigious workers and that their argumentation was about their only recreation. They did not smoke, and, indeed, were abstemious in all their habits, except in the matter of debate.

Professor Verrill's memory for details was almost uncanny. It was generally believed among us younger men that he could tell correctly at any time the exact number of spines on any parapodium on any species of annelid that he had studied, and he had studied those of the New England coast so effectually that no one has attempted to do much in a systematic way since his time. It was a matter of surprise to those who came to know him well to discover in him a kindly heart and a genial nature. It is a pleasure to record that he is still vigorous and complaining, as usual, because there are not more than twenty-four hours in the day. Professor Sydney Smith, too, is still much alive, and in spite of the great affliction in the loss of his sight, is still unquenchably bright and cheerful.

A peculiarity which Professor Verrill possessed as an arguer may be commended to any who may have to play the part of disputant. No matter what the nature of the interruption might be, or how often the interruptions were made, he never allowed them to divert him from the main course of his argument. I have often heard Mr. Sanderson Smith engaged in a furious debate with Professor Verrill, generally during the progress of dinner, where the fury, however, was all on the one side, and manifesting itself in frequent and energetic interruptions and expostulations, during which Professor Verrill would patiently pause, and, after the breath of his opponent was exhausted, take up his argument where it had been interrupted, and, with even voice, continue as if nothing had been said on the other side. By and by, at the proper place he might reply to the interjected arguments.

Richard Rathbun was working in the laboratory in those days. His special interest then was in parasitic copepods. He was a most industrious worker and smoked an amazing number of cigarettes while at work. His tireless industry in those days was prophetic of his subsequent, indefatigable, vacationless, administrative labors to which the splendid achievements of the National Museum are in no inconsiderable degree due.

George Brown Goode was one of the most well-balanced minds it has been my privilege to know. I remember very well his wonderfully clear and honest eye, his great expanse of forehead, his ready and intelligent interest in what we younger men were working at, his wise and stimulating suggestions. It is much to be regretted that he had not been chosen by one of the great universities, where, in surroundings less permeated with administrative detail, he might have developed the talents which I am sure would have made of him a great teacher, with a longer span of life than was his portion.

John A. Ryder, the most gifted, the most original, the most profound, the most unconventionally human of them all, withal a most likable man, stands out prominently among the workers at the Fish Commission laboratory in the 80's. Often have I sat in wonderment as I listened to his conversa-

tions, which were, indeed, largely monologues, and recall also a remark of Rathbun's, made a few years later. He said that Ryder would awaken lively interest at the meetings of the Biological Society in Washington, and hold their undivided attention throughout the entire meeting, although, often, he confessed, no one was exactly certain what he was actually talking about. He was wonderfully suggestive and always interesting. After having been a member of the faculty of the University of Pennsylvania for but a few years, he died at a comparatively early age. His death, as was that of the talented and beloved Montgomery, who some years later succeeded him to the same chair, was a calamity to the science of biology in this country.

Theodore N. Gill appeared to me to be a rather elderly man in 1882, but he could not have been much above fifty years of age. He was then and, unless his memory has yielded to the weight of years within the past few months, still is an animate ichthyology in himself. How a memory such as his could develop in these days of printed books, with their tabulated lists and bibliographies alphabetically arranged for ready reference, is a marvel. Names of varieties, species, genera, families, orders, synonyms, authorities, morphological details, literature in many tongues, seemed to be always at hand and ready for immediate use. In the variety, extent and accuracy of his knowledge he stands in a class by himself among the men I have known.[3]

Dr. Jerome Kidder, naval surgeon, was another of the interesting and capable men that Professor Baird attracted to himself and the commission. He had charge of such investigations as required a knowledge of chemistry. His personality is still a very real presence in my memory where he stands as a model of good-breeding, good-humor and good-fellowship. He was possessed of intellectual endowments of signal brilliancy. His early death was mourned by a much wider circle than that bound to him by the ties of kindred.

Tarleton H. Bean was not engaged in field work much of the time in the years of which I am speaking, although he had been much in the field in the earlier days of the commission. As I remember him he was always animated and cheery, abounding in interesting and amusing anecdote, with an extensive and accurate knowledge of fishes and their ways.

Captain Z. L. Tanner, in 1882, was in command of the *Fish Hawk* whose construction he had superintended. Before that time he had been in command of the *Speedwell.* When in 1883 the *Albatross* was placed in commission he became her commander. While a naval officer with the rank of captain, he was not a graduate of the Naval Academy, but had been promoted for distinguished services in the Civil War. He had a florid complexion, a somewhat harsh voice, and a bluff and hearty manner, such as one naturally associates with the typical ship's captain. He was a strict disciplinarian, but just and impartial, and highly respected by all who served under him, or were in any way associated with him.

Captain J. W. Collins was the designer of the U. S. Fish Commission schooner *Grampus* and her first skipper. The *Grampus* was intended to be a model fishing schooner, and is distinguished as the prototype of the *We're Here* of Kipling's "Captains Courageous." He is remembered by me for his cordial and approachable maner, his profound knowledge of the fishing industry, especially on the Banks,

[3] Professor Gill died September 25, 1914, aged seventy-seven.

and for his narratives of his own personal experiences and of those of others. One incident, the truth of which I have no reason to doubt, was that of two of his acquaintances, who loaded two dories from the flesh of a giant squid, which they found floating at the surface, leaving an amount which they estimated would have made another dory load. Other incidents of his narrating were not meant to be taken literally, as, when speaking of his experiences in Copenhagen, when attending an international fisheries meeting, where he said that it rained so much that horses frightened at a person who was not carrying an umbrella. Then there was his story of the commander of a vessel, who, sailing into his home port on the Norway coast when there happened to be no fog, did not recognize the place, and accordingly put out to sea, when, the usual fog setting in, he succeeded in a few hours in making his own familiar harbor.

Captain H. C. Chester had charge of the collecting apparatus and superintended the dredging operations. The trawls and nets were stored in what is now called the Stone Building, then known as the Old Candle Factory. Captain Chester was an ingenious and true son of the Nutmeg state. His inventive genius was highly valued by Professor Baird, as an examination of the Reports will show. He abounded in quaint and original humor. He had had much experience as a sea-faring man. It was well known among us that Captain Chester had taken a prominent part in the *Polaris* expedition, and that it had been due to his unflagging good-spirits in the presence of intense cold and extreme privation that the party that returned by land was brought through safely. We often tried to get him to tell us about that expedition but never succeeded. He preferred to talk about Noank, Connecticut, which he invariably spoke of as "the garden spot of the earth," and a famous variety of apple, which his father developed to grow in an orchard on a steep hill side. These apples, he averred, were flat on one side, which kept them from rolling down hill into his neighbor's field below.

Sanderson Smith I remember as an elderly man, probably Professor Baird's senior. I think that he had been an engineer by profession, but with a strong bent towards natural history. His work for the commission, besides looking after the mollusca, consisted in tabulating results of soundings, dredgings, temperature data, and the like. He was a model of good nature, more ready to do favors for others than to minister to his own comfort. In those days there were many visitors to the laboratory and Sanderson was always ready to drop his work, which the rest of us sometimes did reluctantly, to show visitors over the laboratory. James H. Emerton, Professor Verrill's artist, was very patient under these visitations to his table, but one day, I remember, he complained vigorously because some of the visitors had breathed down the back of his neck as they were watching him make a sketch.

Soon after we moved into the new residence building some of us one morning found Sanderson looking with a much puzzled expression at the new clock, across the face of which was printed a direction for winding, but which he was interpreting as a weather forecast. Pointing to it with an air of indignant agitation he said: "Why, why, why, what, what, what does that mean? 'Wind every Monday morning'!"

Leslie A. Lee was a most cheery and well-beloved member of Professor Baird's larger family in the 80's. He was an enthusiastic collector, capable of the best work, but whose love of collecting and of first-hand

observation overrode his inclination to put his knowledge into printed form. His publications bear no proper relation to his work and knowledge.

H. L. Bruner, one of the assistants in my time, grave and serious as a young man, was assiduous and painstaking in his work, and immune to sea-sickness. J. Henry Blake, who succeeded Emerton as artist, and was in the laboratory for three or four years, is another who has built himself a pleasant habitation in my memory.

Among the young men who worked in the laboratory on Little Harbor in 1882 and 1883 were also B. F. Koons, W. E. Safford, Peter Parker and Ralph S. Tarr. Tarr was so much impressed with the accuracy of Vinal N. Edwards as a weather forecaster that he declared that if Vinal Edwards said it was not going to rain in the afternoon he would still believe him even if his own senses told him that there was a genuine downpour.

A year or two later, Professor W. Libbey for at least a summer, and Professor W. B. Scott, as an occasional visitor, brought new ideas and methods, and Dr. McCloskie, too, brought a breeze of enthusiasm with him that was most refreshing.

Among the numerous visitors to the laboratory who tarried long enough to impress their strong personality on us younger men I recall most vividly and pleasantly Professor Cope and Doctors Osler and S. Weir Mitchell.

It is not my purpose to extend these reminiscences much beyond the days when Professor Baird's presence was the most potent influence in this community. I shall, however, insert a few observations on the season of 1889.

Returning after a year's interval, I found a complete change in the personnel, and but little change in the spirit which pervaded the laboratory. The laboratory was under the efficient directorship of Dr. H. V. Wilson. The laboratory workers still had their mess in the residence building, where I greatly missed the benign presence of Professor Baird.

There was here, however, that summer, a man of quiet and unobtrusive manner, who, as it seems to me, had elements of real greatness in his nature in higher degree than any one whom it has been my fortune to know. That was Professor W. K. Brooks.

It was an interesting lot of young men that I found in the laboratory of the U. S. Fish Commission in 1889. There was E. A. Andrews, then and still of Johns Hopkins University; H. V. Wilson; F. H. Herrick; E. R. Boyer, C. B. Davenport, and W. M. Woodworth, post-graduate students of Harvard; M. C. Greenman, a post-graduate student of the University of Pennsylvania; R. P. Bigelow, C. F. Hodge, T. H. Morgan, and Sho Watase, post-graduates of Johns Hopkins. Of this group, Hodge, who has recently molted the effete east, has written of dynamic biology. I think it can be said with truth that he and the others of this little group, after the quarter of a century that intervenes, are to be reckoned as among the potent dynamic agencies in the biological science of this generation.

The Marine Biological Laboratory had been opened the previous summer. Dr. Whitman had already inaugurated the custom of having evening lectures. They were held in the one laboratory building in the room, I think, in which the invertebrate course is now conducted.

In 1889 cross-breezes were ruffling the calm of the biological atmosphere. There were some in the laboratory who stoutly denied that the surroundings did or could have any manner of influence on the germ cells. There was no god in animated nature but heredity and Weismann was his prophet. In those days also the neo-La-

marckians were in the land; sturdy Americans they were, who hardened their hearts at ideas made in Germany. One evening, I remember, we went over to the Marine Biological Laboratory to hear a lecture by Professor E. D. Cope. The lecture was on some mechanical factors in evolution. Professor Cope, the most scintillatingly brilliant American man of science that has yet appeared, told us about the shapes of the carpal bones in a number of extinct artiodactyles which he had been studying. He illustrated his lecture with numerous crayon sketches which he made while he was talking. His conclusion was that these bones owed their shape to the mechanical effects of pressure and stress, and were thus evidence of the inheritance of characters that had become impressed on lines of descent by the surroundings, and hence might be said to prove the inheritance of acquired characters. I recall that one of the young men, upon our return to the Fish Commission laboratory, characterized Professor Cope's lecture as puerile, which I did not think then, nor do I think now, is exactly a word that is needed to describe anything which Professor Cope said or did in 1889.

It has been my fortune once and again to hear more or less patronizing criticism of the way time was spent in the work of collecting and classifying the animal and vegetable forms which inhabit the waters of the Woods Hole region. Doubtless the time could have been better spent, but this remark may be made with equal justice concerning any sort of human endeavor. It may not be amiss to say that whatever the character of the publications of these earlier workers, the conversations to which, as a young man, I listened between such men as Professors Baird, Gill, Verrill, Smith, Goode, Ryder and Cope, contained nothing about priority of names, and little upon taxonomy in general, while they did abound in discussions of such matters as the habits and distribution of animals, adaptation, development, function, behavior and heredity.

Looking back on the laboratory activities of those days and comparing them with the present with its varied application of the sciences of chemistry and physics to the study of the phenomena of life, the work done here in the 80's may seem narrow. It should be remembered, however, that no science has sprung at once into maturity. The immediate problem before the Commission of Fish and Fisheries was that of acquiring all the knowledge obtainable of the fishes of our coast and of their food and environment. It is not conceivable that this knowledge could have been gained in any other way than by a study of the conditions at first hand. Doubtless our knowledge is to be vastly extended by those experimental methods whereby animals are subjected to conditions which do not exist in nature, but such investigations, however valuable they may be in refining and extending our knowledge of life, would have been as much out of place in the days of Baird and Agassiz as the automobile and the locomotive would have been in the forests of this country 200 years ago.

Those of us who breathed the serene atmosphere of the days of Professor Baird, and have continued work somewhat similar to that which we began some three decades ago, have inherited, I trust, some of his kindly spirit that should enable one to listen to criticism with equanimity and to endure patronage without agitation of mind. Thus one may dwell beside the road and be a friend to the passing biological pageant. So he could be a respectful onlooker when, in 1898, he beheld the passing show, brave with many colors; when newborn ideas in biology must first be baptized in corrosive sublimate and then decked in

the royal purple of hematoxylin before they could be exposed to the awed gaze of the beholder. Likewise, in 1899, when the name of vom Rath was a word to conjure by; continuing in 1900, when nerve endings were the end and aim of all that was worth while, he could only wonder and be silent. I remember in 1899 asking an acquaintance that I had made the previous year what he was working at. His reply was: "I have been working for the past two years on the nerve endings of *Arenicola*, but have not got any results yet." But with the introduction of experimental methods the epoch of zoological fads came to an end. Now our dweller beside the road listens with appreciation to illuminating lectures on a variety of subjects, where problems new and old are attacked from various and unusual points of approach and by a multiplicity of methods. He listens with delight to the lecturers who announce the results of their researches, but with a conviction that is sometimes in inverse proportion to his knowledge of the subject under discussion. Often he is inclined to accept these conclusions with enthusiasm, only to have his enthusiasm chilled when he hears what the lecturer's friends have to say about the lecture on the following morning.

When, in more recent years of the Fish Commission, or Bureau of Fisheries, as it is now called, Parker, with no other equipment than a pair of hat-pins, demonstrated the functions of the otoliths of fishes, and, with an apparatus which he constructed with the aid of a saw and hammer, supplemented by a simple surgical operation, discovered the function of the lateral line in fishes, and in equally simple fashion cleared away the fog that enveloped our knowledge of how much or how little fishes hear sounds either above or beneath the water; when Sumner showed by ingenious but easily worked experiments the degree to which flat-fishes adapt themselves to their surroundings; when Field gave proof as convincing as that of the proverbial pudding that *Mytilus edulis* is truly an edible, and that the smooth dog-fish by some other name would be eagerly sought in the markets; when these pieces of original work and others like them, of which many could be named, are considered, we feel that they represent in good degree the kind of investigation which would have won Professor Baird's hearty sympathy and approval. I am inclined to think, however, that he would have viewed with still greater favor the Bulletin of the Bureau of Fisheries for 1911 reporting a Biological Survey of the Waters of Woods Hole and Vicinity.

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THE INTERNATIONAL ENGINEERING CONGRESS

THERE will be held at San Francisco, from September 20 to 25, 1915, an International Engineering Congress, organized and conducted under the auspices of the American Society of Civil Engineers, the American Institute of Mining Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers and the Society of Naval Architects and Marine Engineers. General G. W. Goethals has consented to act as honorary president and is expected to preside over its general sessions. The following eminent engineers have consented to serve the congress as honorary vice-presidents: Professor Richard Beck, Sir J. H. Biles, Otto T. Blathy, Commander Christian Blom, Professor André Blondel, Dr. C. E. L. Brown, Dr. Emil A. Budde, Henry Le Chatelier, Professor Hermann Hullmann, Wm. Henry Hunter, Professor Luigi Luiggi, Rear Admiral Yoshihiko Mizutani, W. M. Morday, Sir Charles Parsons, Jean L. de Pulligny, V. E. Timonoff, R. P. J. Tutein-Melthenius, H. H. Vaughn, Sir Wm. Willcocks.

The papers to be presented before the congress will cover the general field of engineering and will be published in ten volumes.

The papers in general are intended to treat the various topics in a broad and comprehensive manner and with special reference to the important lines of progress during the past decade, the present most approved practises and the lines of present and future development.

The general fee for membership in the congress is $5, which will entitle the member to receive the index volume and any single volume of the transactions he may select, together with the right of participation in all the general activities and privileges of the congress. The committee of management must know at the earliest practicable date the number of members in the congress. Effective plans in regard to the publication of the transactions, as well as all arrangements looking toward the proper ordering of local affairs during the week of the congress, require this information.

It is expected that there will be arranged a number of excursions to points of engineering and general interest within practicable reach of San Francisco, and every effort will be made to enable visiting engineers to inspect personally such engineering works as are especially typical of engineering on the Pacific Coast. Further information of general interest and importance regarding the congress will be given publicity through the technical press, and to all subscribers notice will be sent containing more complete information as to papers, sessions of the congress, excursions, travel routes and itineraries, hotel rates and accommodations, and other matters of importance.

Mr. W. F. Durand is chairman and Mr. W. A. Cattell is secretary of the committee of management, the address of which is Foxcroft Building, San Francisco.

EDITH JANE CLAYPOLE

The following minute in memory of Dr. Edith J. Claypole, who died in March, as a result of infection incurred in the preparation of typhoid vaccine for the armies of Europe, has been adopted by the Science Club of Wellesley College. It has also been embodied in the minutes of the Academic Council:

The Science Club of Wellesley College records its sense of loss in the death of Edith Jane Claypole, a charter member of the club, its first secretary, and active both in its foundation and in its early conduct. Descended from a father who was himself a distinguished man of science, and receiving her early education at home, she was by inheritance and training exceptionally fitted for the line of work to which she chose to devote her life. She early exhibited unusual capacity for research; in the field of cell-studies and pathology her many papers are evidence of her power of achievement. As a teacher she opened the eyes of her students to the beauty and significance of living things, revealed to them the method of science, and inspired them with the high nobility of its aims. Members of other departments recognized the open-mindedness and appreciation that marked her attitude toward all branches of scientific activity. As a physician she early became interested in preventive medicine, and to its advance she devoted herself without reserve. Through her researches in pathology, particularly in certain obscure cases of infection and in typhoid immunization, she won distinction, and in the application of these researches to the needs of humanity, she has now crowned her service with the gift of her life. Her charm of manner and winsomeness of spirit, with a strong and wholesome nature, quick and tender in its response to the needs of others, and her unfailing steadfastness in friendship, endeared her to large circles. We, the members of the Science Club, express our sadness in the loss of a comrade, and our appreciation of her service to science and to humanity.

SCIENTIFIC NOTES AND NEWS

The Civic Forum Medal of Honor awarded annually for "distinguished public service" has been presented to Mr. Thomas A. Edison.

Dr. Abraham Jacobi was the guest of honor at a dinner in the Hotel Astor given by the physicians and officers of the Bronx Hospital on the occasion of his eighty-fifth birthday.

At the annual meeting of the American Academy of Arts and Sciences, held on May 12, at its house, 28 Newbury Street, the following officers were elected:

President, Henry P. Walcott; *Vice-presidents*, Elihu Thomson, William M. Davis, A. Lawrence

Lowell; *Corresponding Secretary,* Harry W. Tyler; *Recording Secretary,* William Watson; *Treasurer,* Henry H. Edes; *Librarian,* Arthur G. Webster; *Chairman of Rumford Committee,* Charles R. Cross; *Chairman of C. M. Warren Committee,* Henry P. Talbot; *Chairman of Publication Committee,* Edward V. Huntington; *Chairman of House Committee,* Hammond V. Hayes.

At the annual election of officers of the Boston Society of Natural History, the following were chosen: *President,* Edward S. Morse; *Vice-presidents,* Robert T. Jackson, Nathaniel T. Kidder, William A. Jeffries; *Secretary,* Glover M. Allen; *Treasurer,* Edward T. Bouvé; *Councillors for Three Years,* Charles F. Batchelder, Reginald A. Daly, Merritt L. Fernald, William L. W. Field, John C. Phillips, William M. Wheeler, Edward Wigglesworth, Mary A. Willcox.

The Barnard gold medal awarded every fifth year by Columbia University, on the recommendation of the National Academy of Sciences, "to that person who, within the five years next preceding, has made such discovery in physical or astronomical science, or such novel application of science to purposes beneficial to the human race, as may be deemed by the National Academy of Sciences most worthy of the honor," will be given this year to William H. Bragg, D.Sc., F.R.S., Cavendish professor of physics in the University of Leeds, and to his son, W. L. Bragg, of the University of Cambridge, for their researches in molecular physics and in the particular field of radioactivity. The previous awards of the Barnard medal have been made as follows:

1895—Lord Rayleigh and Professor William Ramsay.
1900—Professor Wilhelm Conrad von Röntgen.
1905—Professor Henri Becquerel.
1910—Professor Ernest Rutherford.

The Butler gold medal to be awarded every fifth year by Columbia University for the most distinguished contribution made during the preceding five-year period to philosophy or to educational theory, practise or administration will be given to the Hon. Bertrand Russell, F.R.S., lecturer and fellow of Trinity College, Cambridge, for his contributions to logical theory. The Butler silver medal is to be awarded to Professor Ellwood Patterson Cubberley, of Leland Stanford Jr. University (A.M., Columbia, 1902; Ph.D., 1906), for his contributions to educational administration.

The city of Philadelphia, acting on the recommendation of The Franklin Institute, has awarded the John Scott Legacy Medal and Premium to Herbert Alfred Humphrey, of London, England, and to Cav. Ing. Alberto Cerasoli, of Rome, Italy, for the Humphrey Pump, a device for raising water by the direct application of the explosive energy of a mixture of combustible gas and air. In the pump, the momentum of a moving column of water is utilized to draw in and compress in a suitable chamber a charge of the gas mixture whose explosion raises the water.

The Edward Longstreth Medal of Merit of the Franklin Institute has been awarded to the late Mr. George A. Wheeler for his escalator. The basic invention was first disclosed in a patent granted to Mr. Wheeler in 1892, and a number of patents were subsequently issued to him for improvements and developments.

At the annual meeting of the Boston Society of Natural History, held on May 5, the two annual Walker Prizes in Natural History were awarded. The first, of sixty dollars, was given to Miss Emmeline Moore, of the department of biology, Vassar College, and the second, of forty dollars, to Miss Edith B. Shreve, of Tucson, Arizona. The two successful essays were entitled, respectively: "The Potamogetons in Relation to Pond Culture" and "An Investigation of the Causes of Autonomic Movements in a Succulent Plant." These annual prizes are awarded for the two best essays submitted on subjects selected by a committee of the society. For the years 1916 and 1917 the committee announces that competitive essays will be received on "any subject in the field of natural history" thus allowing wide scope.

The Howard Taylor Ricketts Prize for research in the department of pathology and hygiene and bacteriology at the University of

Chicago has this year been awarded to Miss Maud Slye for her work on "The Influence of Inheritance on Spontaneous Cancer Formation in Mice." This prize is awarded annually on May 3, the anniversary of Dr. Rickett's death from typhus fever acquired while investigating that disease in Mexico City.

MR. C. E. LESHER, associate geologist of the land-classification board of the United States Geological Survey, has been assigned by the director of the survey to take charge of the work of compiling the statistics of coal production published in the annual volume "Mineral Resources." This work has heretofore been directly under Edward W. Parker, whose resignation from the Geological Survey is effective July 1.

DR. EDWARD C. ROSENOW, of the Memorial Institute of Infectious Diseases, Chicago, has been appointed chief of bacteriologic research, Mayo Foundation, Rochester, Minn. Dr. Rosenow will begin his new work on July 1.

THE following have been appointed by the trustees of Columbia University as the board of managers of the George Crocker Special Fund for Cancer Research for three years from July 1 next: Dr. T. Matlack Cheesman, Dr. Walter Mendelson, President N. M. Butler, Dean Samuel W. Lambert, Professor Warfield T. Longcope, Professor William G. MacCallum and Professor Francis Carter Wood.

DR. J. ALEXANDER MURRAY has been appointed general superintendent of the Imperial Cancer Research Fund and director of the laboratories, in succession to Dr. E. F. Bashford.

DR. LENTZ, director of the Prussian imperial health office, has been appointed the reporting councilor in the medical department of the ministry of the interior, as successor of Dr. Abel, who has been transferred to the Institute of Hygiene at Jena.

MR. LEO E. MILLER writes to the American Museum of Natural History from South America that he has completed his work in Antioquia and on March 30 sailed from Barranquilla to Colon *en route* to Bolivia, where it is proposed to inaugurate a zoological survey similar to that which the museum has conducted in Colombia for the past five years. Mr. Miller's collections, amounting to two thousand birds and mammals, has been received by the museum.

DR. ROBERT F. GRIGGS, of the department of botany at the Ohio State University, has been selected by the National Geographic Society to lead an expedition to study the vegetation of the Katmai district in Alaska. The purpose of the expedition is to study the means by which vegetation gains a foothold on the volcanic ash with which the country was covered by the eruption of Katmai in 1912. This ash-covered region is many hundreds of miles in extent, covering a portion of the Alaska Peninsula and the greater part of Kadiak Island.

AN excursion to the Hawaiian Islands, under the charge of Professor George H. Barton, director of the Teachers' School of Science, will leave Boston on July 4.

MR. LLOYD B. SMITH, of the Associated Geological Engineers, has returned to Pittsburgh, after spending three months in the oil fields of Mexico and Central America.

ALVIN J. COX, Ph.D. (Breslau), instructor in chemistry at Stanford University from 1904 to 1906, has returned to San Francisco on a leave of absence to take charge of certain features of the Philippine exhibits at the exposition. He has held the position of director of the United States bureau of science in the Philippine Islands.

PROFESSOR W. H. KAVANAUGH, head of the experimental engineering department, University of Minnesota, has been appointed a member of the international jury of award, department of machinery, at the Panama Exposition, San Francisco. Professor Kavanaugh is spending the month of May at the exposition judging exhibits.

PROFESSOR H. H. STOEK, head of the department of mining engineering of the University of Illinois, has been granted a leave of absence to act as a member of the Committee on Awards for Mining Exhibits at the San Francisco Exhibition. Professor Stoek is now in California.

PROFESSOR ROBERT A. MILLIKAN, of the University of Chicago, delivered the "Thomas Lectures" at Richmond College in April. The general topic was "The New Physics." In his first lecture Dr. Millikan recounted some of the important recent discoveries in the field of radioactivity and X-rays and discussed the significance of these facts to modern science and life. The second lecture was given to a description of some of the properties of the electron, and the methods by which these properties had been discovered.

DIRECTOR JOHN F. HAYFORD, of the College of Engineering of Northwestern University, addressed the engineering sub-division of the Chicago Association of Commerce on Friday evening, May 14, on the subject "Chicago as an Engineering Center."

PROFESSOR LOUIS KAHLENBERG, of the University of Wisconsin, delivered the annual address before Phi Lambda Upsilon, the honorary chemical society of the University of Michigan, at Ann Arbor, on May 13. The subject was "A Neglected Principle of Chemistry and some of its Applications."

UNIVERSITY AND EDUCATIONAL NEWS

THE trust estate of $3,250,000 left by Miss Elizabeth Thompson, will on the death of her brother and sister be equally divided among the following institutions: The Children's Aid Society, the New York Association for the Improvement of the Condition of the Poor, the New York Historical Society, the Society of the New York Hospital, the Presbyterian Hospital and Columbia University.

THE Michigan legislature has appropriated $350,000 for the erection of a new university library building for the University of Michigan.

THE James Buchanan Brady Urological Institute of the Johns Hopkins Hospital, made possible through Mr. Brady's gift of $600,000, was formally opened on May 4. Among those who made speeches were Dr. Hugh H. Young, head of the institute, and Dr. William H. Welch.

DR. THOMAS ORDWAY, of the Harvard Medical School, has accepted the deanship of the Albany Medical College. Dr. Ordway was formerly professor of pathology in the medical school of which he now becomes dean.

G. V. COPSON, now specializing in dairy bacteriology in the University of Berne, Switzerland, has been appointed instructor in pathological and dairy bacteriology at the Oregon Agricultural College.

DR. E. F. MALONE, of the department of anatomy, University of Cincinnati, has been promoted to be associate professor of anatomy.

DR. ERNEST LINWOOD WALKER, formerly chief of the biological laboratory of the Federal Bureau of Science, and chief of the department of medical zoology at the University of the Philippines, Manila, has been appointed associate professor of tropical medicine at the George Williams Hooper Foundation for Medical Research, University of California.

PROFESSOR R. C. LODGE, who has been this year at the University of Minnesota, has been appointed professor of philosophy and psychology at the University of Alberta.

DISCUSSION AND CORRESPONDENCE

BALANCED SOLUTIONS AND NUTRITIVE SOLUTIONS

MR. TRUE'S article on "Antagonism and Balanced Solutions"[1] closes with the following remarks.

> In both sea water and the more or less dilute nutrient solutions present in the soil, normal life is sustained, as a rule, only in mixtures of proper proportions and necessary concentration. Since salts are required in both cases to overcome the harmful action of pure water, as well as that of the salts themselves, there seems to be no reason to seek to limit the use of the term "balanced solutions" in the manner suggested by Loeb and Osterhout. Unless we admit that malnutrition due to a deficiency in nutrient salts is a form of toxicity excited by the substances present, we can hardly escape the alternative proposition that the missing salts are injurious *in absentia*.

Since the writer is responsible for the introduction of the term physiologically balanced salt solutions,[2] he may be pardoned for pointing out that in his opinion neither of the

[1] SCIENCE, N. S., XLI., No. 1061, p. 653, 1915.
[2] Loeb, *Am. Jour. Physiol.*, III., p. 445, 1900.

two alternatives in the last sentence of Dr. True is correct. The writer defined physiologically balanced salt solutions as solutions in which the toxic effects are annihilated, which each or certain constituents would have if they were alone in solution. Thus the fertilized egg of *Fundulus* develops naturally in sea water, is killed in a pure NaCl solution of the concentration in which this salt occurs in sea water, and is kept alive if some $CaCl_2$ or $KCl + CaCl_2$ is added. Since the egg lives and develops perfectly normally in distilled water the $CaCl_2$ or $KCl + CaCl_2$ are only needed to counteract the directly injurious effects which the NaCl solution produces as soon as its concentration exceeds a certain limit (about $m/8$) (but not to counteract the injurious effects of distilled water which do not exist in this case). The nature of this injurious action of the NaCl solution of a sufficiently high concentration is perfectly well known, since it consists in the injury or destruction of the specific impermeability or semipermeability of the membrane.[3]

The term *physiologically balanced* or *protective* salt solution was intended to be used in contradistinction to the term *nutritive* solution. If from a *nutritive* solution one or the other constituent is omitted (*e. g.*, K or NO_3 in the case of plants or K or the ion NH_4 in the case of bacteria) so that a malnutrition or a deficiency disease follows, it can not be stated that the organism suffers from the toxic effects of the salts left in the solution (as in the case of a pure NaCl solution of a sufficiently high concentration) but it suffers because the missing elements are indispensable building stones in the construction of the complicated compounds of the organism. The writer is not aware that anybody has proved that NO_3 or K or PO_4 in the nutritive solution of a plant are merely needed to overcome the toxic effects of the rest of the constituents of the nutritive solution; while in the case of *Fundulus* the experiments with distilled water show directly that the egg does not depend for the building up of an embryo upon any of the salts contained in the sea water or any other physiologically balanced solution.

In the writer's opinion the last sentence in Dr. True's note should read as follows: A deficiency of nutritive salts deprives the organism of some of the necessary building stones for the construction of its specific complicated compounds, and this deprivation may result in the formation of inadequate or directly injurious compounds, causing the phenomena of malnutrition or of the "deficiency diseases."

JACQUES LOEB

THE ROCKEFELLER INSTITUTE
FOR MEDICAL RESEARCH,
NEW YORK

[3] *Pflüger's Archiv*, CVII., p. 252, 1905; *Biochem. Ztschr.*, XLVII., p. 127, 1912; *Jour. Biol. Chem.*, XIX., p. 431, 1914.

THE TYPICAL CASE EXEMPLIFIED[1]

I RECEIVED three offers when I came up for my degree; two from institutions in the east and one from a typical state university in the northwest. The opportunities for scholarly work were pictured to be as great by the western university as by the two eastern, and the former offered me considerably more in salary than either of the latter. Everything else being equal, the difference in salary decided the case. I came west, was disillusioned, and now wish that I had chosen differently; but, by the light that I had to follow, I could not have made a different choice. Therefore, it is with the purpose of casting some new light upon the offers that come from the west that I now write.

In general, the positions out here seem more attractive than those in the east, because usually the beginning salaries are higher—the fact that the maximum salary is much lower is overlooked or disregarded; and because usually the opportunities for scholarly and research work are represented to be as large. Or, rather, I should say, misrepresented, for all the time that I have had for original work I have taken from my sleep and recreation.

In the correspondence that I had with the head of my department and with the president of the university in reference to the position,

[1] See the letter by Professor Edward C. Pickering, SCIENCE, February 19, 1915, p. 288.

they spoke glowingly "of the opportunities in a comparatively new institution in a rapidly growing section of the country," and assured me that "every facility will be given you to continue your research work." My program as outlined by mail was reasonably light; but when I came to assume my duties I found that I was expected to grade all the quiz and examination papers. Consequently a great part of my time during the first year was spent with the blue pencil. In my correspondence pertaining to the position this sentence appears: "Graduate or advanced student assistance will doubtless be furnished," if I should become unduly burdened with academic work. I have made several requests for assistance, but so far have been denied it.

Nevertheless I was determined to keep the pot boiling, and I was, after a short delay, at work upon a minor problem. My first requisition for apparatus was granted immediately. I was forced to wait three months for my second; and when I made my third request I was asked the startling question, "Are you conducting personal research?" If so, I should have to meet personally the expenses of such work. I could not answer the question at first, for I did not know what personal research was, never having heard the phrase before; but when I learned that work which is self-initiated is personal, I realized that my work belonged to that category. The officer of administration with whom I had this conversation tried to show me that it was an imposition on my part to make this request. Why! had he not done research in San Francisco, in Omaha, in Chicago, in New York, yes, and in London and Paris too—the results of which, he informed me, were published in pamphlet form—and he did not request or expect the university to pay his expenses. So my third requisition was refused. This attitude toward original work is characteristic, and is not due entirely to ignorance of scholarly work, but in part to the importance and emphasis that the university gives to its correspondence and extension work.

These departments receive very liberal support. Courses are given in nearly every subject, and nearly every member of the faculty gives some of his time to extension work; some men give their entire time to it. The extension department is probably the most important in the university. This is due to the fact that the popular lectures which are given by the faculty upon their extension tours offer the best means of gaining the people's good will. Here, where the university and the agricultural college exist as separate institutions, there is much need of this. Public favor means appropriations. Therefore it is not research but extension work that the administration desires.

One's endeavors upon the extension platform soon receive recognition and promotion, whereas research work is disregarded. It is not wanted; it is not encouraged, no matter what may be said to the contrary. I have talked the matter over with several members of our faculty, with men who have been here for eight and ten years, and they agree with me—in fact I have advised with them in writing this letter—that there is no future here for a man with scholarly ambitions. And the pity of it all is that there are many men who have no desire to continue research after their doctorate, and who would be supremely happy in these positions, where the work is new, where the people are eager for knowledge, and where no one is critical; but the administration, by feigning to hold certain ideals, attracts and elects men to the faculty who are entirely out of sympathy with the conditions of their work as soon as they discover them. The man who comes imbued with the spirit of research and who desires to continue his scientific investigation will struggle hopelessly for a year or two against the odds, and will then resign; either resign his position and return east, or resign his scholarly ambitions. If he return east he must start again at the bottom; if he remain at his post he will be discontented in the sacrifice of his ideals—a victim of dry rot.

I feel rather strongly in this matter because I am myself at the parting of the ways. I too must "resign." Which course I shall pursue is a question that is giving me no little concern. It is one, also, that I feel should never

have been forced upon me; but it is one that all who have come out here, with ideals such as mine, have been forced sooner or later to meet. The issue should have been placed squarely before me two years ago when I was considering the position. Had I then known that research was practically impossible I should never have come to the northwest. One can never learn the true conditions of an appointment from correspondence with the administrative officers. They are naturally biased. For that reason I have written this letter. I sincerely hope that it will enable others to choose less blindly than I.

X.

A TYPICAL CASE

PROFESSOR ——— graduated at ——— University and, taking a postgraduate course, received the degree of Ph.D. He then went abroad, studied at ——— University, and returned to America, full of enthusiasm for original research. He had published an important memoir for a thesis which was well received, his instructors encouraged him and his fellow students appreciated and were interested in his work.

He now received an offer of a professorship in a small country college, married and began his new life, expecting to continue his investigations. He soon found that almost all his strength was consumed in teaching, and was horrified at the end of his first year that his salary had not been increased, as had been promised upon satisfactory service. This induced him to review his forces and readjust to the situation. He assumed a more sympathetic attitude toward the tyro and looked deeper into the organization and purposes of the institution. He began to fall in with the teaching problem and reduced the expenses of his department by taking a larger number of classes himself and for a nominal sum employed a few bright upper classmen a few hours weekly to do the drudgery. He attacked the problem of efficiency in instruction and found himself well equipped for the undertaking, for the machinery of his superior training gave a diamond point to his drill in the form of system and habits of thought, and this was backed up by the battering-ram of a growing enthusiasm.

He also became interested in the historical and vocational aspects of his subject and began to relate himself and his work to the world he lived in. In process of time his ideas began to show themselves in increased comfort and efficiency in the lives of human beings. His teaching task was now a magnet to all his powers, while his classes forgot their examinations in the joy of their daily lessons.

On the Olympic heights of the university he had learned to despise the rôle of the sturdy farmer and faithful wife who were responsible for his birth and education and much of the ethics of that parental pair had become a mere convention or a timely expedient. But there stole into the years of the busy Ph.D. a renewed conviction of the high worth of social purity, and his fictitious ideas of temperance, kindness, etc., gave way to principles more in keeping with his earlier teaching, while he ceased to despise the ultimate source of his bread and butter.

The finding of such men as this—men adaptable to the highest needs of the small country college—would be a worthy object for a Committee of One Hundred.

S. L. MACDONALD

FORT COLLINS, COLO.

SCIENTIFIC BOOKS

Animal Experimentation and Medical Progress. By WILLIAM WILLIAMS KEEN, M.D., LL.D., professor emeritus of surgery, Jefferson Medical College, Philadelphia, with an Introduction by Charles W. Eliot, LL.D., president emeritus of Harvard University. Boston and New York, Houghton Mifflin Company, The Riverside Press, Cambridge, 1914. Pp. xxvi + 312.

In this book Dr. Keen has brought together the thirteen papers on experimentation which he has published in various periodicals during the past twenty-nine years. Nine of these deal chiefly with the contributions which this method of research has made to medical—and chiefly surgical—progress, while the remaining papers are devoted to the antivivisectionists and what they have been doing. Not him-

self an experimenter, but convinced beyond recall of the absolute necessity of animal experimentation, the author is a veteran in its propaganda, and no one writes with fuller knowledge of the facts on both sides, with keener conviction of the correctness of his position, and with a more trenchant pen. With him it is "a common-sense, a scientific, a moral and a Christian duty to promote experimental research," just as "to hinder it, and still more, to stop it would be a crime against the human race itself, and also against animals."

The eminence of Dr. Keen as a surgeon adds all the more value to his opinion of the benefits which human surgery has derived from experimentation. A striking chapter in the book is that on modern antiseptic surgery and the rôle of experimentation in its discovery and development. It gives a graphic picture, first of the pre-antiseptic surgery with its terrors of suppuration, secondary hemorrhage, erysipelas, lock-jaw, blood poisoning, gangrene and high death-rate—a picture all the more graphic because of the author's experience with its realities; then of Lister's work, with his experiments upon one horse and one calf; and finally of the results, with the virtual elimination of the disastrous sequelæ of operations, the extraordinary reduction in mortality, and the wide extension of surgical treatment to formerly forbidden fields. Shortly after the battle of Gettysburg the author was called in one night to five cases of secondary hemorrhage; since 1876, when he began the practise of the antiseptic method, he has not seen as many such cases in all the years that have elapsed, nor has he seen a single case of hospital gangrene. Formerly healing by "first intention" was so rare that its occurrence was regarded as a triumph; now its absence is a disaster. Formerly a famous surgeon lost two out of every three of his patients after the operation of ovariotomy; now the mortality is often less than one per cent. The skull cavity and the abdomen with its organs were once avoided by the surgeon; now they are fearlessly entered. "The only question," says the author, "is, should Lister have made this final test first on a horse and a calf, or on two human beings? Can any one with a sane, well-balanced mind hesitate as to the answer?" "In the past thirty years," he continues, "experimental research has produced a more fruitful harvest of good to animals and to mankind than the clinical observations during thirty preceding centuries."

To the present reviewer that aspect of the antivivisection agitation that is by far the most interesting is the psychology of it. It is characterized preeminently by an exaggerated love for animals, woeful ignorance, a proneness to make strong pronouncements without adequate knowledge, a disregard of facts, a lack of logical reasoning, a tendency to pervert the truth and to ascribe unworthy motives to scientific men, and a general lack of moral balance in propaganda. These qualities have been demonstrated so frequently that they have come to be expected as a matter of course in those who oppose the practise of animal experimentation. As a fact it is rare that one fails to find some of these qualities in all such persons. Dr. Keen has been impressed by this and he states the attitude of many of us when he says: "I have been compelled to conclude that it is not safe to accept any statement which appears in antivivisection literature as true, or any quotation or translation as correct, until I have compared them with the originals and verified their accuracy for myself."

The four chapters here devoted to the antivivisectionists are entitled "Misstatements of Antivivisectionists," "Misstatements of Antivivisectionists Again," "The Influence of Antivivisection on Character" and "The Antivivisection Exhibition in Philadelphia in 1914." These papers teem with specific instances illustrative of the peculiarities of the antivivisectionists, many of them dealing with the classical, oft-quoted examples of supposed barbarities of the experimenters. To any one who has read of these and who supposes them to be as charged in the indictment, the reading of the present book is highly recommended, for it shows how often and how wickedly the truth has been perverted for partisan purposes. Dr. Keen handles without gloves the opponents of scientific progress.

No one, in America at least, has been more roundly denounced by them, yet this denunciation, it may be mentioned incidentally, results in making him all the more cheerful. No earnest and unprejudiced seeker after the truth can turn from the perusal of this book without a feeling of disgust at the iniquitous kind of warfare that has been waged by the enemies of progress and without a keen recognition of the utter feebleness of their attitude. In relentlessly exposing them Dr. Keen deserves the gratitude of all men and women who love truth and humanity.

FREDERIC S. LEE

COLUMBIA UNIVERSITY

An Introduction to the Study of Physical Metallurgy. By WALTER ROSENHAIN, B.A., D.Sc., F.R.S. New York: Van Nostrand Company. 390 pages, 6 × 9. Illustrated. Net $3.50.

The book is divided into two parts, the first section dealing with the structure and constitution of metals and alloys, the second with the properties of metals as related to their structure and constitution.

Taking up first of all the microscopic examination of metals, the author discusses the preparation of specimens, and the microscope used, then the microstructure of pure metals and alloys. This is followed by the thermal study of metals and alloys, the thermal diagram and its relation to the physical properties. Typical alloy systems are exemplified by the lead-antimony, lead-tin, zinc-aluminium, zinc-copper, tin-copper and certain ternary alloys, followed by the iron-carbon system.

The second part first reviews the mechanical testing of metals, the effect of strain on the structure, heat treatment, mechanical treatment and casting, and ends with a discussion of defects and failures.

To review the contents of this book thoroughly would take many pages, because the author has covered the broad field of metallography so thoroughly and so well. This is particularly true of the presentation of the comparatively new ideas on the structure of metals, the effects of strain and of annealing, developed from Beilby's amorphous metal theory. The elongation of the crystals when strained, the production of slip-bands and their nature, the formation of amorphous layers and the hardening of metals by cold work, twin structure, fracture under tensile, shock and alternating stress conditions, the amorphous cement theory, are all most clearly set forth. The criticisms therefore must be on minor points and not on the broad lines of the book.

For example, on page 13, after mentioning the names of the earlier workers, Sorby, Martens, Osmond, Werth, Grenet, Charpy, Le Chatelier, Heyn, Wüst, Tammann, Andrews, Arnold, Roberts-Austen, Stead, Howe and Sauveur, the author says: "The fact that the present author was privileged to count Roberts-Austen and Osmond amongst his personal friends, and that Arnold and Stead are still actively at work in this field, serves to show how very recent the whole development has been." Besides Arnold and Stead, many of those mentioned are "still actively at work" as current literature in the metallographic field amply proves.

On page 21, in describing the preparation of specimens for polishing, "the necessity of gripping the specimen in the vise" to file it is mentioned. Most people grip the file in the vise and rub the surface of the specimen on it.

On page 31, the reference to etching reagents is too short and might with advantage be expanded.

On page 162, as Ruff's work is mentioned, reference ought also be made to that of Wittorf and of Hanemann.

The photomicrographs are all well chosen and excellently executed, but lose somewhat in not having a title beneath each, rather than in the list of plates.

In conclusion, the only change that could be suggested is in the section on the thermal diagram which should contain those diagrams showing partial solubility in the liquid state. A short classification according to solubility in both liquid solid states would help.

The author has succeeded in preparing an excellent book, interesting to the student, valuable to the metallurgist and engineer, and full of ideas for any one engaged in metallographic research. It is a book that can be

recommended to the general reader also, because the style is simple and the ideas are clearly and logically developed and followed. With the growing interest in metallography as a method of testing and of research it will undoubtedly prove very popular.

W. CAMPBELL

SPECIAL ARTICLES

THE TEMPORAL FOSSÆ OF VERTEBRATES IN RELATION TO THE JAW MUSCLES

ABOUT two years ago one of us (Gregory) discovered that the superior and lateral temporal fenestræ of all two-arched reptiles and the single fenestra of all one-arched reptiles appear to be related to the jaw muscles in such a way that they either give exit to them upon the top of the skull or afford room for them at the sides. It was afterward learned that Dollo[1] had reached the same conclusion in 1884, but his important results have been practically ignored in the subsequent literature of the temporal fenestræ, which have been considered too largely from a purely taxonomic viewpoint and too little with reference to their adaptational significance.[2]

More in detail, the steps leading to the present note were chiefly as follows:

It was observed that the temporal fossæ of *Cynognathus* and other Theriodonts present close resemblances to those of primitive mammals and it thus seemed highly probable that in these reptiles the sagittal and occipital crests, together with the zygomatic and postorbital borders, bounded the homologue of the mammalian temporalis muscle. Comparison with the snapping turtle *Chelydra* suggested that in this case also the backwardly prolonged sagittal crest served for the attachment of the temporalis; and this gave added significance to the immense temporal fossæ and massive mandible of *Chelone*. The partial excavation of the dorsal roof over the temporal muscles in *Chelydra* appeared to give this muscle more room for action, and the almost complete removal of the temporal roof in *Trionyx* seemed to give further evidence in the same direction.

In *Sphenodon* it was seen that the borders of the superior temporal fenestræ apparently served for muscle attachment, and dissection of a specimen of this animal showed that this inference was correct, and that the lateral temporal fenestræ gave room for the expansion and contraction of the voluminous muscle mass. It was further recalled that in the most primitive Tetrapoda (stegocephalians and cotylosaurs) as well as in primitive Osteichthyes (*Polypterus*, Devonian Rhipidistia, Dipnoi, etc.) the temporal region is completely roofed over, while modernized forms such as Urodeles, Anura, lizards and snakes have the outer temporal roof reduced to slender bars or even entirely absent. The presence of a sagittal crest in *Amphiuma* indicated that in the modernized Urodeles the temporal muscles had extended on to the top of the skull. From such observations the following inferences were drawn:

1. That in primitive vertebrates the chief temporal muscle-mass (adductor mandibulæ of sharks) was originally covered by the dermal temporal skull-roof.

2. That in modernized Amphibia and Reptilia, as well as in birds and mammals, one or more slips of the primitive adductor mass had secured additional room for expansion by perforating the temporal roof either at the top or at the sides or in both regions at once; much as in hystricomorph rodents a slip of the masseter has invaded the region of the infraorbital foramen, so that it now extends through a widely open arcade and finds room for expansion on the side of the face.

3. A comparative study of the skull of *Tyrannosaurus*,[3] in connection with the above-mentioned observations and conclusions, led to the suspicion that the antorbital fenestræ of

[1] "Les Muscles éleveurs de la Mandibule et leur Influence sur la Forme du Crâne: Cinquième Note sur les Dinosauriens de Bernissart," *Bull. Mus. Roy. Hist. Nat. Belg.*, Tome III., 1884, pp. 136–146.

[2] A partial exception to this statement is afforded by Professor Lull's well-studied reconstruction of the cranial musculature of *Triceratops* (*Amer. Jour. Sci.*, Vol. XXV., 1908, pp. 387–99).

[3] Partly embodied in Professor Osborn's memoir on *Tyrannosaurus*, *Mem. Amer. Mus. Nat. Hist.*, N. S., 1912, Vol. I., Pt. I.

dinosaurs, phytosaurs, pterosaurs, etc., were also functionally connected with the muscles of mastication; but it was realized that proof of this view required a wider study of the jaw muscles of living reptiles. It was afterward found that Dollo (1884) had suggested that the antorbital fenestræ of extinct reptiles were filled by the pterygoid muscles.

4. With regard to the supposed relations of the mammals with the Theriodont reptiles, it was thought that some light on the origin of the mammalian alisphenoid and pterygoid and on the probable steps in the transformation of the reptilian into the mammalian condition could be obtained by a study of the muscles of the pterygoid region in existing reptiles and mammals.

5. The supposed transformation of the reptilian quadrate, articular and angular, into the mammalian incus, malleus and tympanic, respectively, as held especially by Gaupp,[4] Gregory,[5] Broom[6] and Watson,[7] might, it was thought, be further elucidated by a careful reconstruction of the jaw muscles of *Cynognathus* and by a study of the muscles of the middle ear in mammals (m. stapedius, m. tensor tympani).

6. In directing the studies of graduate students upon the structural and phylogenetic history of the skull in vertebrates it was found advantageous to emphasize the functional meaning and importance of the chief openings in the skull, and to consider the osseous elements in the temporal and pterygoid regions as if they were mere remnants, or tracts of bone, resulting from the reduction of an originally continuous dermal covering, through the moulding influences of the jaw muscles.

7. In comparing the skull patterns of the oldest Osteichthyan fishes (Dipnoi, Rhipidistia, etc.) sutures came to be regarded as loci of movement or progressive overgrowth, conditioned in part by muscular action, while centers of ossification were considered as loci of relative stability.

At this point the junior author of the present note undertook to make a broad and at the same time sufficiently detailed study of the jaw muscles of vertebrates, partly with the view of testing and extending the foregoing observations and conclusions.

It was soon found that while many anatomists had made intensive studies of the innervation of the muscles of mastication in certain types very few had attempted to follow them throughout the vertebrates and no one had given an adequate series of figures. It is indeed a surprising fact that comparative myology is so briefly treated in the standard textbooks. The work has been carried on in the laboratory of vertebrate evolution in the American Museum of Natural History. A series of 26 existing types of vertebrates has been studied and figured as follows: Elasmobranchii 1, Chondrostei 2, Holostei 1, Teleostei 3, Crossopterygii 1, Dipnoi 1, Urodela 3, Anura 1, Chelonia 1, Rhynchocephalia 1, Lacertilia 2, Crocodilia 1, Aves 1, Mammalia 7. In each case special attention has been paid to the innervation of the muscles as a guide to homologies. By means of these data, and of the principles that became apparent as the work proceeded, reconstructions of the jaw musculature were attempted in the following series of extinct forms: *Dinichthys* (Arthrodira), *Eryops* (Temnospondyli), *Labidosaurus* (Cotylosauria), *Cynognathus* (Cynodontiæ), *Tyrannosaurus* (Theropoda). The full results of this study will be published elsewhere by Adams, but meanwhile it may be worth while to record the chief general conclusions which we have reached in collaboration.

1. It seems impossible to work out the jaw musculature of *Dinichthys* either on the dipnoan or on the ordinary teleostome bases and a study of the muscle areas by Adams indicates a unique type of jaw movements, a fact of no little phylogenetic significance, in view of the disputed relationships of this group.

2. The above mentioned conclusions of Dollo and of Gregory regarding the origin of

[4] "Die Reichertsche Theorie," *Archiv. für Anat. und Entw.*, Supplement Band, 1913.

[5] *Bull. Amer. Mus. Nat. His.*, Vol. XXVII., 1910, pp. 125–143; *Jour. Morph.*, Vol. XXIV., 1913, pp. 23–35.

[6] *Proc. Zool. Soc.*, 1912, pp. 419–25.

[7] *Proc. Zool. Soc.*, 1914, pp. 779–85.

the temporal and antorbital fenestræ of reptiles are reinforced by much additional evidence.

3. The inferred conditions of the jaw musculature of *Cynognathus* are entirely in harmony with the views (*a*) that in the mammal the back part of the reptilian jaw became transformed into the accessory auditory ossicles; (*b*) that the basal portion of the mammalian alisphenoid is homologous with the reptilian pterygoid as suggested by Watson,[8] while the ascending portion seems to have been derived from the epipterygoid, as held by Broom and Watson.

4. In the transitional pro-mammals the reptilian pterygoid muscles pterygoideus anterior) became greatly reduced in correlation with the reduction of the elements behind the dentary; a possible vestige of these muscles may be the tensor tympani muscle, which runs from the basicranial region to the handle of the malleus. The mammalian internal and external pterygoid muscles are only partly homologous with those of existing reptiles and represent slips of the capiti-mandibularis mass, developed as the new joint between dentary and squamosal became established. The loss of the descending flange of the reptilian pterygoid, the secondary separation of the pterygoids along the mid-line and the transformation of the reptilian transpalatine into the true mammalian pterygoid (as held by Watson) all become more intelligible when considered in connection with the above-described changes in the musculature.

5. As a working hypothesis it is assumed that the transformation of certain elements in the temporal and occipital regions of early Tetrapoda was partly conditioned by the stresses induced upon the skull roof by the jaw and neck muscles. Comparison with lizards, *Sphenodon,* etc., clearly indicates that the prolongation of the parietal into a postero-external process joining the true squamosal was correlated with the squeezing effect of the capiti-mandibularis and depressor mandibulæ muscles. This may also be responsible for the appression and coalescence of the superior and lateral temporal elements (supratemporal and squamosal), in the early reptiles. The shifting of the post-parietals (dermosupraoccipitals) and tabularia from the dorsal to the posterior aspect of the occiput was no doubt influenced also by the forward growth of the neck muscles upon the occiput.

W. K. Gregory,
L. A. Adams
American Museum of Natural History

[8] *Ann. Mag. Nat. Hist.* (8), Vol. VIII., Sept., 1911, pp. 322–23.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE
SECTION D—MECHANICAL SCIENCE AND ENGINEERING

The first session was held in the morning of Wednesday, December 30, in the engineering building, Vice-president Frederick W. Taylor and Dr. Charles S. Howe in the chair, with an attendance of about 130. It was announced that the sectional committee had recommended for election to the general committee for the office of *Vice-president,* Dr. Bion J. Arnold, of Chicago. The following officers were elected by the section:

Member of Council—Dr. Rudolph Hering, of New York City.

Member of General Committee—Morris L. Cooke, of Philadelphia.

Member of Sectional Committee—Dr. Charles S. Howe, of the Case School of Applied Science.

The program of the session was as follows:

Principles of Scientific Management: Dr. Frederick W. Taylor.

Which is to Control Public Works—a Board or a Single Head?: Morris L. Cooke.

The Improvement and Enlargement of Transportation Facilities: George S. Webster.

A Study in Cleaning Philadelphia's City Hall: William H. Ball.

Every city, town and hamlet which owns a public building of any kind is confronted with the problem of efficient and economical cleaning. Public buildings are constantly growing in size and it is becoming more and more possible to handle the problems of their maintenance and operation on a technical basis. The fact that after what must be admitted to have been a crude study, extending over only a few months, we were able to effect economies amounting to over $30,000 a year, or $100 a day, in the cleaning of one public building, shows the possibilities. According to technical and other literature the cleaning of public buildings has been given very little

consideration, particularly from an engineering standpoint.

We must look to the development in this field of definite standards as to both appliances and methods. This standardization must be of such a character as to be applicable wherever work of this kind is done. Most of our present appliances and materials are crude and the outgrowth of almost no study that could be called scientific. While there are undoubtedly inherent difficulties in handling the personnel on the same basis that they are handled in industrial establishments, improvement in this direction has been so rapid in the last few years that we have every reason to look forward to further radical improvements in this direction.

It should be pointed out that there are no inherent differences between the cleaning of private buildings. Therefore, in looking at the whole problem of cleaning buildings, and judged by what it means both in dollars and cents and in the comfort of the occupants, the problem is a proper one for engineering attack and solution.

Experience in Locating and Mapping Pipes and Valves in an Old Water Works System: Carleton E. Davis.

The necessity for complete plans and records of pipes and valves in a water-works system is evident. In many cities, too much dependence has been placed upon the memory of employees and too little stress has been laid upon the importance of accurate and enlightening records so distributed as to be immediately available by as many employees as possible.

In the definite scheme of obtaining and recording such information, much spare time of employees can be used in obtaining data without adding to the general expense. The city of Philadelphia is operating such a system with reasonable success.

New Water Supply Conduit of the City of Hartford Water Works: Caleb Mills Saville.

The development of a new water supply for the city of Hartford, Conn. (pop. 131,000 in 1914), comprises a collecting and storage reservoir, located 14 miles from the city, with a capacity of 9 billion gallons; a compensating reservoir of 3 billion gallons to compensate mill owners for the stream flow taken for the collecting reservoir; a pipe line, conduit and tunnel from the collecting reservoir to one of the existing distributing reservoirs; a filtration plant and a large size main supply line from the distributing reservoir to the city.

This paper tells in detail of the construction of the 3,667 feet of concrete conduit, 2,333 feet of concrete lined tunnel, and 39,660 feet of 42-in. cast iron pipe line. The conduit is of horseshoe section, cut and cover type 5 ft. × 4.75 ft. vertical and horizontal dimensions. Some excavation as deep as 30 feet in the overlying glacial drift was necessary. The construction of the tunnel was preceded by complete diamond drill borings. The geological structure encountered was a basalt lava flow overlying the Connecticut red sandstone.

The construction of the 42-inch cast iron pipe line 7½ miles long is fully described. The canvass of the bids is given, and an unusual way of discriminating between bids for furnishing steel and cast iron pipe, whereby 15 per cent. was added to all bids received for steel pipe.

Latest Advances in Inoffensive Sewage Disposal: Rudolph Hering.

The paper covered the latest advances made towards obtaining an inoffensive collection and disposal of sewage, which has now reached practically satisfactory solutions for nearly all possible cases.

The chief means to prevent all foul odors in the collection of sewage are to maintain (1) a continuous flow and no deposits and retentions of sewage, (2) a frequent flushing and (3) a free air circulation in all sewers.

A large number of sewer systems with these means now continuously deliver an inoffensive sewage.

The means for an inoffensive final disposal of sewage depend on the local possibilities. In nearly all cases the solids and liquids require separate treatment.

1. In sufficiently large masses of flowing water. The liquids can be dispersed in them in well known proportions so that no offense is possible and so that automatic oxidation of organic matter takes place. The solids can be retained and, according to their quantity and character, can be treated economically and inoffensively in efficient ways.

2. On land. The liquids must be oxidized by sufficiently extensive thin film surface contact with bacterial slime, as by percolation through sand, gravel or broken stone, the surfaces of the grains being well covered with slime, and well exposed to air circulation. The oxidation of all organic matter may thus be graded in degree and always be inoffensive.

The solids must be collected under water in tanks under conditions preventing putrefaction, but which cause a sufficient decomposition by bacteria producing chiefly methane gas and carbon dioxide, both inoffensive, and a final sludge re-

sembling humus soil in forests, also inoffensive. This has been made possible by the recent extensive introduction of Imhoff tanks. Quite recently it has been found that a daily mechanical agitation of the sludge and always maintaining its alkalinity, materially hastens the decomposition.

Operation and Efficiency Reports from Water and Sewage Purification Plants: RALPH E. IRWIN.

In Pennsylvania the state commissioner of health is required by law to give a permit for the construction of all water purification plants supplying water to the public for domestic purposes and for all municipal sewage treatment plants. To intelligently issue a permit for the construction of such plants it is necessary to have detailed information concerning the efficiency, manner of operation and construction of existing plants. The commissioner has, therefore, created a section in the engineering division which, under the direction of the chief engineer, inspects and tests plants already in operation.

Operation and efficiency reports should be submitted to the commissioner of health:

1. That the commissioner may know accurate records are being kept by each plant.
2. To give information for answering complaints from those served.
3. To assist in locating the cause of water-borne disease apparently due to public water supplies.
4. That information may be at hand from all parts of the state, thus forming a clearing house for information from plants treating similar waters or sewages and make it possible to indicate the most efficient and economical method of treatment when considering improvements, or the construction of new plants.
5. To allow checking results from one plant with another to show inaccuracies or carelessness.
6. To give information for interpreting results of analyses submitted by plants, those served, or results of samples analyzed at the commissioner's laboratory.
7. To give information upon which to base suggestions for the prevention of waste of chemicals, wash water, etc.
8. To assist in judging the efficiency of operators in charge of plants.
9. To have records at hand showing when inspections and tests are necessary and to assist in this work.

At the present time in Pennsylvania there are 115 water filtration plants and 91 sewage treatment plants in operation. Also, there are a large number of chemical dosing plants installed for the disinfection of dangerous water supplies and insufficiently treated sewage.

The New York Sewage Disposal Experiments and Plant at Brooklyn, N. Y.: GEORGE T. HAMMOND.

The experiment plant described in this paper was authorized by the Board of Estimate and Apportionment of the City of New York, $50,000 being provided to cover the cost. One of the most difficult sewage disposal problems which the city must solve is afforded by the rapidly progressing pollution of Jamaica Bay—a tidal reservoir 19.28 square miles in area and very shallow, the situation of an important oyster industry. The population contributing sewage to this bay is 250,000 persons, of whom 210,000 are in Brooklyn. The sewers are on the combined plan and discharge 18,000,000 to 22,000,000 gallons of dry-weather flow into the bay daily. Storm-water flow from the sewers at times reaches over 1,000 cubic feet per second and is very foul. One of the principal purposes of the experimental plant is to find the best means of treating this sewage.

The plan of the experimental plant provides for pumping the sewage to an elevated supply tank, from which it is fed by gravity to the experimental units. The amount of sewage used by the plant is about 1,200,000 gallons per day. The experimental plant includes three Imhoff tanks of varying size and depth; six sprinkling filter beds; one tank-aerator for treatment of sewage with compressed air supplied by an air compressor; one siphon-aerator, which treats sewage by compressed air, which is supplied by the flowing stream of sewage through a hydraulic air compressor siphon; one gravel strainer, or roughing filter; four settling or sedimentation tanks; six secondary sedimentation tanks; ten sludge drying beds of the Imhoff type. Various types of screens, including a Riensch-Wurl screen. Various experiments are also provided for the disinfection of sewage effluents and for various methods of treating and disposing of sludge and screenings. All of the units of the plants are constructed on a working scale, each one large enough for testing the actual operation conditions of a full-size plant.

Some Considerations Affecting the Disposal of Sewage at Seaside Resorts: MARSHALL R. PUGH.

For a distance of approximately one hundred and twenty-five miles the coast of New Jersey has an almost continuous line of summer resorts, some large and some small. Some of the considerations theoretical and constructive, affecting the disposal of sewage at seaside resorts may be briefly stated as follows:

The Collecting System.—(1) Use self-cleansing velocities where possible, but do not be bound by them when they result in a cost incommensurate with their benefits. (2) When self-cleansing velocities can not be wisely adopted, make adequate provision for flushing. The sewers must be kept clean.

The Disposal Plant.—(1) The plant must be adapted to great seasonal variations in flow. (2) The capacity of the ocean to digest and purify the sewage, being the most economical and effective means of attaining this end, should be made use of. (3) Where bathing is an asset, the discharge of crude sewage to sea is not permissible. (4) Single-story tanks furnish in general the method best adapted to treating the sewage of resorts before its discharge to sea. (5) Nuisances from such effluent do not arise if tanks and appurtenances are correctly planned and the discharge effected through a properly designed outlet, at a sufficient distance from shore, and in ten feet or more of water. (6) It would appear from what evidence we now possess that no ill effects to health result from the proper discharge of such effluent. (7) Owing to the difficulties encountered in work along the coast and under the surface of the ocean, careful consideration must be given to durability and to the means of executing the work called for by the plans.

Preservation of Wood: P. A. Maignen.

The railroads are said to spend $121,500,000 a year in cross ties. If all these ties were treated properly by a good preservative process, it would be possible to save more than $450,000,000 in 25 years. Wood is composed of two principal parts, cellulose and sap. Cellulose resists decay a long time. The decay begins in the sap and extends to the cellulose. It is therefore urged that some ways and means of removing the sap from the wood be found. Many attempts have been made to render the sap proof against decay without removing it, but the result has not been satisfactory.

The preservatives used in the United States in 1913 were: 108,373,359 gallons of creosote; 26,466,803 pounds of zinc chloride, and 3,885,758 gallons of other preservatives. In that same year there were 153,613,888 cubic feet of timber treated by all preservatives. Of the creosote used only 38 per cent. was produced in this country and 62 per cent. was imported.

At present 30 per cent. of the railroad ties are treated. If a satisfactory method of impregnation could be devised so that the wood could get the full benefit of a thorough penetration it would not be long before all the ties would be treated. Unfortunately the impregnation, as carried out now, does not penetrate the wood sufficiently. In experiments it was found that one specimen from which the sap had been removed was impregnated throughout the whole length of the wood; whilst the other specimen of the same kind, but whose resins had not been extracted, was impregnated not more than a few inches from each end.

The second session was held on the afternoon of Wednesday, December 30, Vice-president Dr. Frederick W. Taylor and Mr. O. P. Hood in the chair, with an attendance of about 95. The program of the session was as follows:

Municipal Highways—a Problem in Maintenance: William H. Connell.

The three foremost problems involved in the operations of a highway department are: Organization, maintenance and construction.

A good organization is essential particularly in so far as maintenance is concerned, as it is practically impossible to continuously and systematically maintain pavements and roads in first-class condition, in an economical manner, without a good working organization built up along the lines best adapted to cope with the conditions involved in this important branch of work coming under the jurisdiction of a highway department. By this it is not intended to give the impression that the maintenance organization should be separated from the construction, as separate organizations are apt to result in an overlapping of jurisdiction and a tendency to shift responsibility, and open up a field for unlimited excuses as to whether the construction or maintenance division is responsible for any unsatisfactory conditions that may arise relative to the pavements. Furthermore, it is obvious that the logical organization to maintain the pavements is the one that saw them laid and is familiar with every detail of the construction, as very often a knowledge of apparently trivial conditions in connection with the construction bears an important part in the future maintenance.

Routine maintenance includes such work as the regular street cleaning in municipalities, and the cleaning of country roads and gutters, and any other work of this character that is more or less routine and should be performed under definite schedule. The streets in the thickly populated sections of the city should be cleaned every day; in less thickly populated sections, every other day; every third day, and so on until we come to the

country roads which should be cleaned once a week, once every two weeks and some only once a month, depending upon the amount and character of the traffic which largely governs the frequency with which the cleaning should be done. The amount and schedule of work and the force necessary to perform it can be determined upon in advance and carried on in a systematic manner under a regular organization, more or less military.

General maintenance includes repairs to streets and roads, and involves different characters of work, each requiring special knowledge on the part of those engaged in the actual performance of the physical work for which special gangs have to be organized. Stone block, wood block and brick repairs, for example, require skilled laborers who have made a specialty of this work and are employed under the title of pavers and rammers; while repairs to asphalt and bituminous pavements must be performed by men specially skilled in this line of work, in addition to the necessary force engaged at the mixing plants. Macadam road repairs, the care of earth roads, and bituminous surface treatments, also require men specially trained, and while it is desirable to train the gangs for each particular branch of this work, such, for example, as bituminous macadam built by the penetration method, water-bound macadam, bituminous surface treatments and the care of earth roads, the three classifications, namely, block repairs, bituminous pavement repairs (mixing method), and macadam, earth road and bituminous surface treatments, represent the three branches into which the organization is usually divided.

Methods for the Elimination of Politics from Administration of Highway Departments: LOGAN WALLER PAGE.

We have a system, if it may be called such, of public roads approximating 2,300,000 miles. The people as a public corporation are yearly consenting to the expenditure of about $200,000,000 in a haphazard endeavor to make this vast road investment pay. That it is a losing investment, conducted on lines directly opposed to those of the best managed private corporations, is an established fact. It is estimated by road experts who have made a careful study of the various phases of the road question, that the American people yearly lose at least $50,000,000, directly and indirectly, because of their careless supervision of these traffic facilities.

State supervision seems to be the first and most effective step toward obtaining satisfactory road conditions. But there are certain evils for which the people of the state should provide safeguards in planning their system of state road management: First, the appointment in each unit or subdivision of only that number of road officials necessary to do the definite duties required of each in that unit, and the necessity for distinct placing of responsibility for work done. Second, some arrangement should be made whereby the road officials shall give the roads continuous and systematic attention, instead of the existing irregular care, which has proved so costly in the long run. Third, the requirement of necessary qualifications which the road official must possess to discharge his duties efficiently. Fourth, the demand that wherever practicable the incumbent of any road office shall be appointed because of his qualifications, in this way avoiding election of those who may prove more able politicians than engineers. Fifth, road officials would best serve the people if the term of office were limited by merit, and not terminated at regular periods. Sixth, provision should be made for a careful study of traffic needs in the individual localities so that political considerations may not be the deciding factor in the location of road improvement, distributing of appropriations, and appointing of needed officials.

Illinois has recently made a notable advance toward centralizing road control, and the placing of men on merit, as each county engineer takes a competitive examination, and is made an assistant to the state highway engineer, thus providing correlation and centralized oversight. In fact, the whole trend of state participation has been toward placing a broader scope of duties and authority in the central state department. This continued trend, it is hoped, will be one of the main factors in solving the problem of supervision, while the intelligent application of the merit system in securing this skilled supervision in road work is the only promising method of eliminating politics from road administration.

Plant Inspection for Pavements: JULIUS ADLER.

It has been a recognized fact that the complete inspection of any engineering structure begins with the materials to be used in that structure, and it is safe to say that this statement applies with full force to street and roadway pavements, in which such a wide variety of materials is now being used, and in which the life of the structure depends so very largely upon the strength, durability and suitability of the materials in resisting the effects of traffic and the atmosphere. The fact, however, that so many uncertainties and diffi-

culties exist even to-day in regard to fixing the desirable qualities of many paving materials is a certain indication that this subject has not received the close study and systematic observation that its importance merits; furthermore, while there has been too great a tendency in some lines to charge all failures to the materials used, or some one of them, rather than to the methods of construction, it is also certain that a considerable proportion of failures in paving work can still be traced to the use of materials, which, if not actually of poor quality, were unsuitable for the conditions at hand.

The desirable scope of plant inspection must first be established before the actual duties and details can be determined. The work may be confined to the general inspection and sampling of materials and mixtures, requiring nothing more than that the contractor shall keep within the more or less broad limits of the specifications, but allowing him discretion and variations within these limits. Going a step beyond this idea, the inspection may be carried on as actual plant control, in which the highway organization assumes the right to specify narrower limits for a given piece of work as to amount of bitumen, hardness of the asphaltic cement, temperature of mixtures, and even to some extent the exact details of the method by which these mixtures are to be obtained. The latter plan, that is, plant control, is the logical one to follow on standard, if not patented pavements as well, from the standpoint that the organization which formulates the specifications should also be most capable of regulating their application.

Specifications Covering the Rolling of Road Crusts of Various Types: Major W. W. Crosby.

The assumption is made that the contract and specifications are to be in the more usual form under which the contractor is "to furnish all the labor and materials and do all the work."

Before proceeding to details, it seems necessary, for the sake of clearness, to state certain general principles in regard to specifications.

In the first place, while it may be necessary sometimes to restrict in details the methods to be followed, generally it will be found more satisfactory to specify the results to be obtained rather than one exact method for reaching the result. Elasticity for meeting variations in conditions encountered will then not be wanting. This is especially true as regards rolling.

Secondly: Where necessary the methods of producing the result may be limited by specific description but this should be done only when unavoidable for the insurance of proper results and for preventing the production of a result which will be offered for acceptance as "just as good."

Thirdly: For economic reasons as much elasticity in the provisions for limits, in the descriptions of the machinery or tools allowed for use, should be given as is practicable.

Fourthly: The specification of the result to be secured should be absolutely definite, clear, and as brief as may be consistent. The specification should so describe the product that no more room for argument as to the fulfillment of the specification will exist than will be occupied by a few questions whose answers can and must be determined by scientific methods, such as physical or chemical analyses and arithmetical calculations or measurements.

The author cites the following specification covering the rolling of the second course of a macadam road as embodying the fundamental principles cited.

Second Course

"After the metal for the second course shall have been spread to the proper thickness and cross-sections, it shall be rolled as hereinbefore provided under the head of 'First Course,' except that water, in connection with the rolling, shall be used as follows: When the rolling shall have been carried on to the point where the metal of the second course will not push or 'weave' ahead of the roller and any depressions or unevennesses have been properly remedied, as provided, the rolling shall be interrupted and a thin layer of sand, screenings or other approved binding material, shall be evenly spread over the surface of the second course metal with as little disturbance of the latter as possible. The quantity of fine material so applied shall be just sufficient to cover the metal and care shall be exercised to avoid its use in excess. Water shall then be sprinkled on the roadway surface and the rolling at the same time resumed, the quantity of water used being such as will prevent the fine material from sticking to the wheels of the roller. The combined watering and rolling shall be continued until the voids of the metal shall become so filled with the finer particles as to result in a wave of water being pushed along the roadway surface ahead of the roller wheel. The watering and rolling shall then be discontinued until the macadam shall have dried out. If then the metal shall begin to loosen and to appear on the roadway surface, or if the voids in the metal shall appear to

be not properly filled, the watering and rolling shall be resumed with the application of only as much additional fine material as may be necessary. Any depressions or unevennesses appearing during the above operations shall be remedied by the contractor as hereinbefore provided, and when completed the macadam shall be uniform, firm, compact and of at least the thickness required and shall have an even surface nowhere departing by more than one inch from the grade and cross sections shown on the plans.''

Life of Bond Issues for the Construction of State Highways: E. P. GOODRICH.

Financial Problems Involved in the Selection of a Suitable Type of Road or Pavement: JOSEPH H. CONZELMAN.

The most common methods of obtaining funds for highway improvements are: by general taxation, by special taxation, by assessments on those particularly benefited, by bond issues and by combinations of these methods. A large part of the work done by state highway departments is financed by appropriations from the general tax.

The paving work of many cities in the United States is paid for with money secured by assessing the abutting property. Some revenue is collected in this way in a few rural districts. Special assessments are not, however, very popular or just in these sparsely settled sections because of the large extent of abutting property owned by individuals, and the low property value. Where assessments are practicable and are paid immediately, this method is an economical means of financing highway improvements.

Bond issues have come into general use as a means of obtaining money for state and county highway work, where a large amount of construction is planned. They render large sums of money available for immediate use, making possible a large amount of improvement which probably could not otherwise be financed. Bonds have been issued, however, in many localities with little consideration of the principles of economics. Money obtained in this way has been used to build roads, parts of which, at least, have worn out long before the bonds issued were redeemable. In other instances no provision has been made for retiring the bonds.

Bonds issued for a period of years not greater than the life of the roads which are to be built, when proper provision is made to retire them, is certainly an economical method of obtaining money. The conditions in some parts of the country, for example, in the grain districts, would seem to justify the issuance of bonds whose term extended beyond the life of parts of the highways built, if money for the work could be raised in no other way. Where fifty-year bonds are used to finance the building of roads or pavements, the fairest method, to the present and future generations, of redeeming the bonds and providing for the necessary reconstruction during the life of the bond, is that method which distributes the cost of the improvement most evenly among those deriving the benefits. The method which will most closely accomplish this endeavor must provide for the determination of the life of the several parts of the improvement, and, on the basis of this determination, distribute the cost of the improvement.

Preliminary Surveys and Mapping of National Highways: CHARLES HENRY DAVIS.

A national highway must be interstate. They must be located along the line of densest population so they may carry the heaviest traffic. This is between the large cities and those lying between them on the center line of water sheds. Fifty thousand miles of such national highways will serve, in the counties through which they pass, 88 per cent. of the urban and 53 per cent. of the rural, or a total of 69 per cent. of the people of the United States. It is here that the greatest rural population and tonnage will be served the best, not by so-called radial roads from railroad stations or towns. If a system of 100,000 miles was built, such roads would carry so nearly the entire rural tonnage as to make the balance negligible. The data for locating such a system has been secured for the forty-eight states. Seventeen have been completed, engraved and printed. Five more are ready for engraving. Every named place on these highways will be shown, whether city, town, village, hamlet, post office or otherwise. Also adjacent communities are shown. These maps will be standard and will require but little revision to keep them accurately up-to-date. The scale is such that straightening or relocating a road between two places will not require alteration of the maps. If a traffic census were taken on the alignment of such a mileage we would gain conclusive evidence as to the correctness of the above statements and thus avoid costly and fatal errors. When completed these maps will occupy a volume 5 in. × 10 in. of only 100 pages (50 sheets 10 in. × 10 in.) which with 44 pages of index of every named place will only be ¼ in. thick, including maps and index. When compared with maps available at present their usefulness and convenience are at once apparent.

Construction of Highways with Convict Labor in West Virginia: A. D. Williams.

The labor of the prisoner should not be exploited for the profit of a few and to the detriment of the honest laborer, but in justice to the man in prison and to society the prisoner should be given some useful and beneficial employment. This employment should be of such a nature as to give back to society in a measure atonement for the debt of transgressing society's laws, so that the prisoner will feel that he has rendered a just compensation for his own acts. The labor should be of such a class as would render the broadest service to all of the people, and not infringe upon the rights of any free laborer any more than possible. But the free laborer should not ask that society support an idle prison population so that he might monopolize all the work. The free laborer has as much right to ask a pension, and would do society much less harm in procuring a pension than in compelling the support of an idle criminal population which will turn on to society a weakened bunch of men. The prisoner for his own good must be employed. This labor should be given upon some class of property or the improvement of some class of property held in common by all the people. Therefore, improvement upon the public roads is a class of development that benefits everybody. This is public property, improved for public advancement, and the prisoner being a public charge can here be justly used for the public's good.

The great good that can come to the public from the use of any prisoner or prisoners is not his labor, but is the improvement of the individual by making of him a useful and beneficial citizen. An investigation on the part of the writer reveals that men or prisoners worked in the open air under a system wherein appeals can be made to the better manhood in their natures make better citizens than those employed in confinement.

West Virginia has a law which provides that the prisoner may elect to labor prior to his trial in case he is denied bail and is unable to give bond. This is a humane step and offers an opportunity for the man who has been wrongly accused to keep up his muscles and to provide in a measure for his family while being detained. The law at the present only permits payment of 50 cents per day if released or gives a credit of $1.00 per day on fine if convicted. The writer believes that this should be made a credit of $1.00 in case of release. The writer further believes that prisoners who work upon their honor and give good service should receive a wage which should be retained until the expiration of the sentence or in case of needy families be given to them. Because a man has transgressed a law and is deprived of his liberty is no reason why he should not retain his responsibility to his family and society should give him this privilege because oftentimes the innocent wife and children are punished more than the man in prison.

Utilization of Short-term Convicts for Highway Work in Georgia: James L. Stanford.

To secure accurate data to form a basis for the investigation of road work for misdemeanant convicts, a questionnaire was prepared and sent to every county in Georgia and the results obtained are presented in a condensed form in this preliminary report.

The State Prison Commission reports that practically all of the misdemeanant and felony convicts, with the exception of the women and those in poor health, are employed in some phase of highway work; 2,441 misdemeanant and 2,740 felony convicts were worked by 124 counties during 1914.

Regardless of the kind of work undertaken by a convict gang, the following factors will be involved, the usual interest on the first cost and depreciation of the equipment of the annual expense of maintaining the convicts. The economical solution is to so adjust the size of road gang as to render the sum of these factors a minimum.

According to reports received and actual experience, which may be said to have passed the experimental stage, a guard can most economically and advantageously handle fifteen men. The number of units composing a gang should be proportionately determined by such factors as the expense per man, mileage of roads to be constructed and repaired, the character of the work to be done, the class of men in the gang, and the equipment provided. The expense per man both as to food and guarding at night increases rapidly as the number of men in a gang falls below thirty and decreases just as rapidly as the gang increases by units up to a certain limit. One night guard can handle a camp of ninety convicts quite easily since the day guards sleep near by and are ready to give him assistance at any time. The guards act as road foremen, hence the expense of employing foremen is obviated and balanced by guard hire. The guards should be hired at a stipulated amount and their wages gradually raised as they become more efficient foremen.

Arthur H. Blanchard,
Secretary

(*To be continued*)

SCIENCE

FRIDAY, MAY 28, 1915

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

DISEASE RESISTANCE IN PLANTS[1]

THE control of fungous diseases in plants may be effected in three different ways: (1) By killing the parasite before it enters the host, (2) by curing the diseased plants, and (3) by growing disease-resistant varieties of cultivated plants or making the susceptible varieties resistant. So far the first method is the one most generally followed, the means employed depending on the nature of the fungus.

It is easier to protect the host from a fungus which combines a highly developed parasitic character with alternation of hosts than from one which spends its entire life cycle on the same host. For example, when rust (*Rœstelia cancellata*) appears in a pear orchard the danger from it may be done away with by removing all juniper trees from the neighborhood, the juniper being the host for the alternate stage of the fungus (*Gymnosporangium sabinæ*). The same measure may be adopted in the case of red rust of wheat (*Puccinia graminis*) in countries in which the fungus does not reinfect directly the wheat but grows in the spring on the barberry (*Berberis*). This disease has practically disappeared from Germany since the removal of all barberry and mahonia bushes from the vicinity.

The destruction of a fungus living on one host only is more difficult because of the fact that this may necessitate the destruction of all diseased plants or parts of them, an undertaking which could hardly be carried out completely. However, if carried

[1] A lecture delivered by invitation at the universities of California, Wisconsin, Minnesota and Cornell, and the Iowa Agricultural College, in October, 1914.

out thoroughly and before the parasite has reached too advanced a stage of development this method may be crowned with success. A striking example of this is the control of pear blight in the Rogue River Valley, Oregon. In this region the disease has been kept within bounds, while in the Eastern States it was permitted to gain a foothold and is now a calamity.

The spraying of potatoes against *Phytophthora infestans*, by which the fungus is destroyed before it is able to penetrate the tissues of the host, may be included in this class of control measures. Another example is the destruction of the smut spores, which cling to the outer covering of the grain, in the case of stinking smut, for instance.

It is a more difficult task to cure a plant already diseased than to prevent the disease, and only in rare cases is the method of cure known, the reason for this being that plants are not organized like animals, and in most cases it is impossible to influence a central system. The cure of fungus diseases of different trees by giving the roots an abundant water supply is an example of treatment based on the principle that many fungi are unable to grow in tissues which show a high water pressure. In dry soils the water content is kept on a low basis and this favors the attacks of the fungus.

Another example of the curing of the plant is the hot-water method of seed treatment for loose smut of wheat and barley, this treatment being founded on the destruction of the fungus germs within the seed.

We now come to the third method of disease control, that is the use of disease-resistant plants. The importance of this method is well understood by both scientists and growers, but the application of the principle, it must be confessed, is in its infancy.

Utilization of the factor of immunity in disease control may be divided into two parts, that is the breeding of resistant plants and the artificial immunization of plants. From a scientific point of view, however, both of these rest on the same basis.

Before a disease-resistant race can be bred resistant individual plants must be found. It is a well-known fact that in the vegetable kingdom closely related species suffer in different degrees from attacks of the same parasite. The difference in resistance of the various species of one of our most important cultivated crops, wheat, is unusually prominent, as shown by the researches of Wawelow. Of the eight botanical species which are generally thought to have produced the cultural varieties of our wheat, *Triticum vulgare, T. compactum* and *T. spelta* are attacked by red rust; *T. durum, T. polonicum, T. turgidum* and *T. monococcum* are resistant; the western European varieties of *T. dicoccum* are resistant, and the eastern varieties of Turkestan are liable to rust. *T. dicoccum dicoccoides,* which was found in Palestine some years ago and which has sometimes been regarded as the ancestor of our common cultivated wheat, *T. sativum,* is also a non-resistant species.

The varying susceptibility of species of the same genus makes it possible to substitute for highly susceptible species others of nearly equal cultural value which are less susceptible or resistant. In the case of the coffee plant very good results have been obtained by this means. It is well known that *Coffea arabica* was completely destroyed throughout the Asiatic tropics by the rust fungus *Hemileia vastatrix.* The related African species *C. liberica* appeared to be resistant to the disease and was brought under cultivation in the entire territory in which *C. arabica* had been grown and in

which coffee culture was possible. The immunity of this variety, however, proved to be of an unstable nature, and as a consequence the growers were obliged to import *C. robusta,* a species having lower commercial value, from the virgin forests of Africa. Because of the fact that *C. liberica* produces beans of much poorer quality than *C. arabica* and *C. robusta* beans of a poorer quality than *C. liberica* their substitution was of restricted value, but it saved the valuable coffee industry in some regions from ruin.

The maintenance of profits with the inferior coffee is made easier by the degeneration of taste among civilized people—the result of standardization in all branches of life. The average man to-day lacks the faculty of determining whether his beef was cut from a Holstein or a Hereford, whether the fowl on his table was fed with barley or oats, whether a wine is natural or sugared, or whether the coffee he drinks is *C. arabica, C. liberica* or *C. robusta.*

Even though the value of the resistant plant is lower, as in the case of the examples cited, the possibility of improving the variety still remains. Two methods may be used toward this end, that is grafting a non-resistant on a resistant variety or crossing the two. The first was followed in dealing with *Phylloxera* of the vine in Europe. The European vineyardists grafted their own highly cultivated varieties on the roots of the American vine, which latter resists the attacks of the parasite, and in this way produced a vine combining the requisite wine-producing qualities of the European vine with the disease resistance of the American vine. In view of these facts it would seem easier to replace the European vine with the American, but this is not practicable, because under European conditions of climate it is not possible to prepare wine from American species. The grafted vine is only an imperfect substitute, because its life is of short duration and the labor of grafting makes its culture expensive.

As the grafted vines are heavy bearers, the disadvantages from their use are not felt as keenly in France, where the aim of the viticulturist is to produce large quantities of wine, as in Germany, which aims to produce "quality wines." The really first-class wines are produced from vines which are permitted to grow only a few grapes, and this, coupled with the fact that the quality of wine improves with the age of the vine, shows that the cultivation of grafted vines is more impracticable in Germany than in France.

Another method of improving disease-resistant wild species and preparing them for cultivation is illustrated in the case of sugar cane. In the eastern part of Asia this plant, especially the high sugar-producing varieties, is subject to the so-called sereh disease, the nature of which is still unknown. In British India, however, the wild resistant Chunee cane was found, but it had too much fibrous substance to be suitable for sugar-producing purposes. Several hundred crosses were made between it, on the one hand, and the Cheribon, on the other. As a result of this crossing, several hybrids were obtained which produce the maximum amount of sugar and are at the same time resistant to the disease. As sugar cane is propagated by using its vegetative parts, that is parts of the stem, these qualities can be readily preserved. Notwithstanding these favorable results, however, our experience with sugar cane has proved that its "immunity" is not permanent, but diminishes in the course of cultivation, and the same is true in the case of the two varieties of coffee mentioned, the disappearance of immunity in

these being relatively rapid. No guarantee of future disease resistance has been found in either the hybrids or in the wild species.

Not only do closely related species show a difference in susceptibility to disease, but varieties and races of the same species behave differently in this respect. An example of this is *Triticum dicoccum,* one variety of which, as already stated, is resistant to rust and the other non-resistant. Additional examples are *T. vulgare,* a few varieties of which are resistant; certain varieties of potatoes with reference to *Phytophthora infestans; Pinus sylvestris* with reference to *Lophodermium pinastri;* and other cultivated plants. This difference in disease-resistance between races of the same species is of far greater importance than the difference between two species, because generally there is greater similarity between the cultural value of the two races.

The occurrence of healthy plants among diseased ones is not absolute proof of the resistance of such plants, and therefore to make sure of the immunity of any special strain careful experiments are necessary. It is not enough to raise a number of plants of an apparently resistant strain in a certain place. The question of resistance should be investigated from the beginning on the broadest basis. One of the principal things necessary is to expose the resistant plants to the fungus causing the disease to which they appear to be resistant. In the case of fungi which live in the soil, such, for instance, as the fungus causing stinking smut, the first requisite is to determine whether they are present and, if not present, to introduce them, while in the case of fungi spread by the wind, such as those causing rust and mildew, the infection should be induced either naturally or artificially.

The presence of the fungus, however, is only one factor in the experiment. The second factor is the disposition of the host plant, that is, its internal qualities, which makes infection possible. The third factor is the coincidence of the infection period with the susceptible condition of the host. When all of these factors are present the possibility of infection is certain, and only under such circumstances will the results be reliable.

Fluctuation in the prevalence of fungous plant diseases is due to the presence or absence of proper conditions for the development of the fungi causing them. For instance, loose smut appears to a very serious extent in certain summers, and naturally it would be expected to be still more prevalent the succeeding summer. The fact is, however, that although spores in sufficient quantity to infect all the flowers in the field were scattered, the disease may be much less serious, the reason being that the plant was not in the proper stage a sufficient length of time to receive the infection, or in other words the weather conditions caused too rapid withering of the flowers to permit infection.

The effect of different conditions on the relation of host and parasite makes it necessary that investigations to determine the resistance of strains shall be carried on not only for a number of years, but also in different localities. Even under such circumstances the outcome may be uncertain. In many cases immune forms when cultivated prove to be only partly immune.

The best opportunity for finding immune strains is afforded by diseases which are of regular occurrence. In such cases it is possible to find with a degree of certainty forms which are immune in a certain locality, but while such experiments may give results of practical value, the

problem of immunity can not be solved in this way.

The third way to obtain immune forms is to select resistant individuals and from them breed pure strains. In the case of many diseases, although certainly not in all, healthy individual plants are found in the diseased plots, and the breeding of immune strains from these individuals would seem to be very simple, but experience has taught the contrary. All the factors pointed out in connection with the selection of immune forms must be reckoned with, but in a still greater degree. So long as the appearance of the disease is the only criterion by which to determine the susceptibility of the plants to disease the experimenter is exposed to all kinds of unknown influences.

Several attempts to breed kinds of wheat immune to stinking smut have been made without any real results. The question of producing such kinds is of great importance, especially for the United States. In the large wheat areas of Idaho and eastern Washington, for instance, stinking smut is very serious, not infrequently causing a loss of twenty-five per cent. of the crop. Inspection of seed in that state discloses the fact that a large part of it is covered with the smut spores, and treatment of the seed with copper sulphate is said to be useless because the soil is so badly infected. In many European countries, however, smut has been completely controlled.

In the case of smut the possibility of infection, as far as the fungus is concerned, is very great. As infected plants are in general not very productive on account of the seed being destroyed by the fungus, it might be supposed that smut-resistant plants would propagate well and that the strains would become immune. This, however, is not the case, and it shows that the breeding of smutless wheat by selection of healthy individuals has little chance of success, a fact which has been proved by experiments already made. That this is an impossibility, however, can hardly be stated definitely, but success could be obtained, if at all, only after tremendous amount of labor in breeding and trying hundreds of forms or by fortunate accident.

It will be remembered that Orton by this method of breeding succeeded in obtaining varieties of cotton and watermelon resistant to *Fusarium* wilt. As the original resistant individuals found in the field gave too small yields, he crossed them with prolific varieties and in this way combined the disease resistance of the one parent with the productivity of the other. A similar thing was done by Bolley with flax and by L. R. Jones with cabbage, both of whom bred wilt-resistant varieties by selection. In the case of wheat, it is the opinion of the writer that there would be better chance of breeding smut-resistant varieties if strains rather than individual plants were selected and crossed with productive varieties. Orton very successfully selected a certain variety of cowpea resistant to wilt disease and root knot, that is, the iron cowpea grown in South Carolina, and crossed it with a more desirable variety. By this means also, that is by selecting certain varieties, some of the *Phytophthora*-resistant varieties of potatoes were obtained, and probably also the square head wheat which shows immunity to *Puccinia triticina*.

Next to field experiments, those in the laboratory might aid in the discovery of resistant varieties of cultivated plants. Such experiments have advantages over those in the field and are practical in case of diseases caused by parasites that may be grown artificially in pure cultures.

The greatest advantage of the laboratory experiments is that in them the experimental plants may be infected at any time and under any conditions. The plants may be kept dry or wet and under different temperatures, they may be fed in different ways, and the factors of growth may be influenced within wide limits. Under such conditions the optimum of infection may be determined for different varieties.

The results of laboratory experiments frequently differ greatly from those of field experiments. For instance, in Wawelow's field experiments *Triticum durum*, *T. polonicum* and *T. turgidum* were resistant to *Erysiphe graminis*, but in his greenhouse experiments they became infected with this disease. Reed's experience in this respect was similar to that of Wawelow. It is the opinion of the writer that the host plants were strongly influenced by circumstances, but Wawelow attributes the different results to favorable conditions in the greenhouse for the development of large quantities of conidia.

Such unbalancing of the host is not infrequent and in the natural environment is due to extreme weather conditions. Some species of *Ribes* are known to be immune to the æcidium of the pine blister rust (*Peridermium strobi*), but these species may be infected and form æcidia under a bell jar. In the field the leaves are infected, this being shown by the development of slight yellow patches, but the æcidia never appear. The same is true in the case of some varieties of wheat with regard to *Puccinia*, according to Fraser, on account of the thickness of the cuticle. This partial immunity is satisfactory for practical purposes, and while partially immune plants suffer in a small degree through reduction of the assimilating surface, they do not increase the danger of spreading the rust, as they form no new sources of infection.

Although some very profitable results have been obtained, as already shown, from the immunity methods discussed, the problem of immunity should be solved in a different way. Immunity must not be regarded as the only definite point to be studied. In the case of every special disease efforts should be made to determine the causes of resistance. That immunity from different diseases is due to different causes is clear and the factors which determine this must now be sought.

The cause of immunity of wheat and barley from loose smut is among the simplest. From the investigations of Hecke and Brefeld it is known that the smut spores are carried by the wind to the stigma and that there they germinate and find their way to the ovule through the pollen tubes. As is generally known, there are varieties of wheat which have closed flowers, which means that fertilization takes place within the glumes. In such cases the smut spores can not reach the stigmas at the proper time, and therefore infection can not take place. In this case, therefore, by investigating the question of flowering the problem of resistance can be solved without artificial infection. Many of the intermediate stages which exist between immune and susceptible races may be detected by close observation. In like manner several races of rye show different degrees of susceptibility to ergot (*Claviceps purpurea*), the resistance being least in those having a long flowering period.

The channel from the calyx to the carpels is open in many varieties of pears. Such varieties are susceptible to infection by *Fusarium putrefaciens*, as Osterwalder has shown. The varieties without the open

channel are protected against this means of infection.

The habitus of a plant may influence its disease resistance. An instance of this is the potato with reference to the late blight (*Phytophthora infestans*). Infection of the potato vine with this disease is caused by the conidia being carried to the leaves by the wind. The conidia remain on the leaves until a drop of water causes them to liberate their zoospores. These swim around in the water for some time, then drop their cilia, germinate, and send a hypha into a stoma. Passing through a potato field shortly after a heavy rain, it will be observed that the leaves of some sorts dry within half an hour, while others remain wet for several hours. Generally the quick-drying varieties are less susceptible to the disease than the slow-drying varieties. Slow drying is the result of the plant's habit of growth, which hinders the evaporation of the rain drops. Such plants have flat leaves. Small, hairy leaves, as well as an airy, open growth of the whole plant, facilitate drying. It is possible that the arrangement of the stomata also may exert an influence on the attack of the fungus.

In the case of the grape leaf the arrangement of the stomata is of great importance. For a long time it was not known why spraying with Bordeaux mixture did not, in all cases, prevent the attack of *Peronospora.* Finally, however, Ruhland and Müller-Thurgau explained this by showing that in the grape leaf the stomata are formed only on the under surface. Spraying of the grape, therefore, can be effective only when the spray mixture reaches the under surface of the leaves, and this fact must be borne in mind when dealing with fungi which enter the leaf through the stomata. A similar thing was observed by the writer's assistant, Dr. Pietsch, whose investigations have not yet been published. He found that the resistance of some Remontant carnations is due to the form of the stomata, which makes it impossible for the hyphae to penetrate them. In some cases, however, the hyphæ can not produce infection even though they penetrate the stomata. In the case of cereals immunity from rust is independent of the stomata.

In cruciferous plants the water pores are the avenues of entrance for many bacterial diseases. The relation between their form and disease resistance, however, has not yet been established.

As may be seen in the case of the potato, the lenticels as well as the stomata may influence immunity. The scab fungus (*Oospora scabies*) after penetrating into the outer layers of the potato establishes itself in the lenticels and causes the surrounding tissues to produce an abnormal corky growth. Bacteria also may enter the lenticels, especially when on account of moist conditions the tissues are forming callus. This callus, however, does not form a sufficient protection, and softened tissue and even decaying spots result.

The lenticels are developed very differently in different varieties of potatoes, and it is therefore important that the relations between them and resistance to scab and bacterial rot be investigated.

The condition of the cuticle may influence infection, as shown by the behavior of cereal seedlings in resisting smut diseases. Such influence, however, is possible only in the very early stages of the seedlings' growth, that is before the tissues have attained full development. Since the germination tubes of smut are able to dissolve cellulose, there must be stored substances which cause resistance, and in this connection silicic acid is probably the first to suggest itself. Indeed the quantity of

this substance is different in seedlings of different kinds. Sorauer found resistance of different carnations to be due to thickness of the cuticle. It might be caused also by the wax layer, which is present in *Gramineæ*, carnations, and other plants.

In his experience the writer found that the wax layer influences the attack of *Coniothyrium* on raspberries. In a large horticultural establishment varieties which were covered by a thick blue wax layer were free from this disease, while other varieties were completely killed. The wax layer may exert its influence in different ways, that is it may prevent direct penetration by the hyphæ or it may act indirectly by causing the moisture to run off the plant. This was observed by the writer in making sprayings with Bordeaux mixture. In the case of plants covered with the wax layer the mixture ran off quickly and left no moisture. Conflicting results have been obtained from observations of *Glœosporium venetum* on raspberries on the fruit farm of the University of Minnesota. There is no difference between raspberries with wax and without wax. *Glœosporium venetum*, however, has very sticky conidia and is held by the wax layer, while *Coniothyrium* spores are washed away.

The hairs on the surface also play a part in this connection. Their unfavorable influence in the case of potato late blight has already been mentioned. A very interesting case of hair-like structures is found in the pea family. In some varieties the seeds are imbedded in a woolly outgrowth of the inner epidermis of the pod. Frequently when pods are infected with *Ascochyta pisi* the fungus penetrates into the interior. In varieties without these hairs the seeds are infected only when they are directly in contact with an infected spot of the pod. But when the interior is covered with the woolly outgrowth the fungus grows as in a culture medium and infects every seed.

The cork, which is without doubt a protecting tissue, is a definite kind of epidermis. The writer has never seen branches of cork elms attacked by fungi, but the common elm is subject to the attacks of several species. In the case of the potato the cork layer has the greatest significance.

The causes of the protecting action of the cork, however, may be different. Certain fungi are able to penetrate this cork layer, such as *Phytophthora*, and probably *Fusarium* and *Spondylocadium*. But the last-named fungus is able to penetrate only the very outermost layers of the potato, where it forms mycelium and sclerotia normally. Whenever it grows into the tissues below it must use the channels already opened by other fungi which may happen to be present. Thick cork layers seem to be impenetrable for *Phytophthora* and *Fusarium*. The questions involved are very difficult to solve, because it is hardly possible to judge whether a cork layer is intact or not.

As small wounds occur very generally, the rapidity with which wound cork is formed is possibly of more importance than the absolute thickness of the cork layer. In the course of work with black leg of the potato the writer was able to study this question. It is easy to cure a bacterial infection artificially. The potato is able to close a wound within a short time by the formation of cork. When the growth of bacteria is diminished by low temperature or drought the potato closes wounds more rapidly than the bacteria can penetrate. The ability to form wound cork varies in different varieties of potatoes. Some varieties begin cork formation within six hours after the wound is

inflicted, while in other varieties it is not begun for forty-eight hours or more. From this it is clear that the former may withstand infection better than the latter. By means of these experiments the relation between the structure of the plant and its bacterial resistance has been established beyond doubt. A similar relation, however, does not exist in the case of fungous diseases, as the fungi may penetrate the newly formed cork.

All the instances cited illustrate the influence of mechanical means of protection. But the plant also often escapes disease by means of rapid growth. A microscopic examination of seedlings attacked by smut shows that a number of seedlings may be infected, and yet only a few of the plants will show the disease, proving that the infection has been suppressed in many cases. In this connection attention is called to the fact that in the case of both stinking and loose smut the infection originates in the seed. The fungus mycelium grows in the seedling, but by rapid growth the latter may outstrip the fungus, which remains in the base of the plant and is harmless.

There are still other factors in plants which may influence resistance but which are not perceptible through the microscope. They may be found by physical or chemical research because they are based on the difference of contents. Probably these factors are of far greater importance than those already discussed. But till now these questions are far from being treated in an adequate manner. The foremost reason for this may be that here we have to deal with chemical substances such as albumens, tannins, etc., and there are few botanists who possess the necessary chemical knowledge to undertake such experiments. A bridge, therefore, must be built between botanists and chemists, and the latter's interest in this question awakened.

One of the best investigations made in this direction up to this time is that of Münch on the immunity and susceptibility of trees. He has shown that susceptibility of woody plants to fungous diseases depends on the quantity of water and consequently on the quantity of air in the wood. This is in accordance with the writer's experiments with *Rhizoctonia* and *Fusarium* which have shown that these fungi also have a high air requirement. In the United States, with its large areas of irrigated land, this fact is of great importance. It is possible that the influence of both of these fungi may be diminished by thorough regulation of water conditions.

A glance at sugars and acids shows that these substances also exert an influence in disease resistance. The presence of benzoic acid in *Vaccinium vitisidæa* is supposed to be the cause of its resistance to fungous diseases. In the same way the tannins have a relation to resistance. This was shown by Behrens in his work on fruit decay and confirmed by Cook and Taubenhaus. On the other hand, sugar favors the growth of fungi, as is shown clearly in the case of apples and pears. Henneberg even claims immunity for some varieties of potato from certain diseases on account of their high sugar content, but this has not been established beyond doubt.

Finally the enzymes exert a definite influence on immunity, the oxydases taking the lead. These ferments work directly or indirectly by producing resistant chemical substances.

This paper, it is believed, gives sufficient idea as to how, in the opinion of the writer, the problem of disease resistance should be dealt with in the future. The present methods should by no means be abandoned, for practical experience and happy accidents may help a great deal, but in addition to carrying out these methods an ef-

fort must be made to establish scientific fundamentals for new investigations. Efforts must be made to find the causes of immunity, and after solving this question to determine without infection the disease-resistant qualities in different varieties and individuals in order to be able to establish the desired resistance and at the same time eliminate undesirable qualities. It is only by working along this line that the breeding of disease-resistant varieties on a scientific basis can be accomplished and results which lie within the limits of possibility obtained.

OTTO APPEL

KAISERLICHE BIOLOGISCHE ANSTALT,
BERLIN-DAHLEM

THE CAVERN OF THE THREE BROTHERS (ARIEGE)

FOR the third time in less than three years it has been the good fortune of Count Begouen of Toulouse to announce the discovery of important works of art left by paleolithic man on the walls and floor of Pyrenean caverns. His two previous discoveries were noted at the time in the columns of SCIENCE.[1]

Quaternary art objects may be classed under two heads: the portable and the stationary. The portable class includes in part carved tools, weapons and ceremonial objects, such as poniards, spear throwers, bâtons, etc. It also includes engraved pebbles as well as carved fragments of stone, bone, ivory and the horn of stag and reindeer; in fact, almost anything that could be seized upon to satisfy the exuberant demands of the cave man's artistic impulse.

Stationary art embellishes the walls and ceilings of caverns and rock shelters. In rare instances the fine clay of the cavern floor was utilized for sketching and modeling purposes. The scientific world has been more or less familiar with the portable class of troglodyte art for more than half a century. Our acquaintance with the stationary art is of more recent date. The first discovery of this kind was made by Sautuola in 1879 at the cavern of Altamira in northern Spain. The scientific world, however, did not grasp the real significance of Sautuola's discovery until, after the lapse of nearly twenty years, similar finds had been made in France.

All three of Count Begouen's discoveries have to do principally with cave art of the stationary kind. In July, 1912, near his country estate of "Les Espas," which is only a short distance from Saint-Girons (Ariège), he found a series of subterranean galleries and connecting corridors opening out of an underground stream bed. On the walls of one of the corridors were several engravings of the horse, reindeer, mammoth, etc. Five days later it was the privilege of the writer to see this prehistoric gallery, called Tuc d'Audoubert, in company with Count Begouen and his three sons.

In October of the same year Count Begouen and his sons succeeded in gaining entrance to an additional gallery of the series, but not until after they had broken down two stalagmite pillars that blocked the narrow passage way. What they found there has already been described. The most notable objects were two figures of the bison modeled in the clay of the cavern floor. They owed their preservation to the accidental sealing up of the gallery ages ago by the stalagmite pillars. In view of their excellence, it is probable that they are not unique examples; that perhaps other similar figures less fortunately situated have been destroyed because the artist did not know how to temper and fire his product.

The need of something less difficult to manipulate than stone, bone, ivory and horn must have been ever present in the experience of the troglodyte artist; it is not strange therefore that he should have finally hit upon clay. This illustrates how near an individual or a race may come to some great discovery and yet fall short of it. Thus was the discovery of the ceramic art left to the later more practical, if less artistic, neolithic races.

The latest discovery of Count Begouen and

[1] N. S., XXXVI., pp. 269 and 796, 1912.

his sons, announced recently in a note read at the French Institute, the substance of which is contained in a letter just received from him, was made only a few days before the declaration of war last August. In fact, it was on July 20, 1914, exactly two years after the discovery of Tuc d'Audoubert, that he and his three sons descended by an opening until then unknown into a superb cavern, which in their honor he has named *Caverne des Trois Frères*. It is about half way between Tuc d'Audoubert and the cave of Anlène, in other words about a quarter of a mile from each. Count Begouen believes that the three caverns are connected by corridors; proofs of a conection between two are already in hand.

The exploration was not only difficult, but also dangerous (there are galleries into which he has not yet been able to penetrate), but one is well paid for the effort because of the beauty and elevation of the ceilings as well as "the numerous prehistoric remains encountered there." On the floor were many bones, flint implements and objects bearing man's handiwork.

The results of their first visits were of such a nature as to foretell an abundant harvest when the work shall have been resumed. Upon a bone fragment there was an excellent engraving of a fish. But the chief display of art was on the walls, especially of the terminal gallery, where more than two hundred admirably engraved figures of animals are to be seen. The following species have already been identified: Mammoth, rhinoceros (the first found in the caverns of the Pyrenees), bear, lion, wolf, deer, reindeer, wild goat, horse, bison, chamois, eel and bird. There are also anthropomorphic figures including a curious female type drawn in black; it seems to be walking almost on all fours with the head surmounted by a reindeer horn. It might represent a human figure wearing a mask, or perhaps a figure with mixed attributes; if the latter, then we have a new note in paleolithic art, for until now that art has revealed no representations of mythologic creatures.

Most of the mural art in the *Caverne des Trois Frères* is admirably done; a small panel with reindeer at rest evidently enjoying themselves is "like a page from an album." From the viewpoint of the engravings this cavern is "certainly the richest and the most beautiful thus far known." In addition to the animal and anthropomorphic figures, Count Begouen noted lines, spots of red or black, and red claviform signs, presumably representing clubs.

War was declared before excavations could be begun. With two of the "trois frères" at the front since then and the youngest having recently joined them there, it can readily be understood why Count Begouen does not wish to return to the cavern so aptly named until he can do so accompanied by his three boys after the war is over. Let us hope that he may have to wait neither long nor in vain.

George Grant MacCurdy
Yale University,
New Haven, Conn.

SOME EARTHQUAKE PHENOMENA NOTED IN PANAMA

In October, 1913, the writer was asked by President Porras of Panama to undertake some investigation into the causes of the earthquakes which, during that month, were felt almost daily in the Azuero peninsula which forms the south central part of the republic.

In the course of this investigation two well-recognized geological principles took on a new and impressive significance for the writer, and a vividness that he had never before been able to clothe them with. These principles are the relation of faulting and fracture to earthquakes, and the elasticity of the earth as expressed in earth-waves.

Simultaneously with the first and heaviest shock the cable line from Panama up the west coast to California broke at a point where it passes over the submarine escarpment from the continental shelf at about 60 fathoms to the ocean depths at from 700 to 1,000 fathoms. The distance on the chart from the 60-fathom sounding to the 784-fathom sounding is less than two miles. It is not known, however, whether the slope between these two points is

uniform or locally abrupt. Not only did the cable break, but the repair boat reported that half a mile of it had been buried in debris on the bottom and had to be abandoned and a new piece spliced in.

It is said that the cable was broken in almost the same place by an earthquake between the years 1882 and 1883.

To the writer the only adequate explanation of the breaking of the cable and the burying of half a mile of it is that movement occurred along an old fault escarpment, or fault zone, which marks the boundary between the continental shelf and the deep ocean basin, and that this movement was great enough to cause the earthquake, resulting in a submarine landslide. It is not known whether the fault displacement broke the cable or whether the submarine landslide caused by the jar of the faulting broke it; of course the jar of the fault movement was the earthquake.

Nearly all of the later shocks felt were accompanied by peculiar underground sounds which, at times, seemed to begin to the eastward of the observer and to die away in 5 or 10 seconds to the westward of him. The sound was not unlike the dull boom made by the fracture of ice on large lakes, due to shrinkage, when the weather has suddenly become extremely cold. The noise of these ice fractures may begin far to the right of an observer and die away in the distance, in a few seconds, to the left of him. After listening, several times, to the underground sounds that accompanied shocks, the writer became convinced that they were due to the formation of small shears or strain-relieving cracks in the rocks, formed perhaps considerably below the surface. A search for such cracks was unsuccessful, due either to the sparsity of rock exposures or to the fact that cracks might not be distinguishable from ordinary jointing, or that they might be parallel, or nearly parallel, to the surface and might not outcrop in the vicinity at all. It is thought that the rock strains would be relieved by many very small fractures along a strained zone rather than by one large break, and the differential movement along each small fracture might be extremely small, possibly measurable say in tenths of an inch.

The breaking of the cable and the burying of a part of it, together with the underground sounds heard several times, as far as the writer can see admit of no other adequate explanation than that herein ascribed to them.

The other geological principle connected with these earthquakes was that of the elasticity of the earth's crust. The writer was on the top of a steep conical mountain peak which stood about 2,000 feet above the surrounding country, when a heavy quake came, causing the mountain to behave like a stiff jelly. One felt as though the mountain were swaying through an arc of several inches. Making ample deductions for the tendency of the senses to exaggerate such an unusual phenomena, it is thought that the swaying motion in a horizontal plane was actually about three quarters of an inch. It was one of the most impressive demonstrations of the elasticity of solid rock, of the somewhat jelly-like motion that can be imparted to a "rock-ribbed" mountain, that one could well imagine. With the motion a dull, heavy underground rending sound began on the northeasterly to northerly side of the mountain and died away in the distance on the other side, being audible for say 20 to 25 seconds.

These underground sounds had a most terrifying effect on the inhabitants, who believed they were about to be overwhelmed by some volcanic catastrophe. The investigation was very successful in assuring them that these dreaded sounds were quite harmless and were not due to any subterranean fires, and that the near-by mountains were not going to turn into volcanoes and overwhelm them as they feared. In spite of this soothing information, however, a few of the natives were unjust enough to criticize the writer for not stopping the quakes as quickly as they wished. Such is "man's inhumanity to man."

Donald F. MacDonald
U. S. Geological Survey

THE THOMAS SAY FOUNDATION

An organization, with the above name, was formed under the auspices of the Entomolog-

ical Society of America at its Philadelphia meeting. Its purpose is to honor the memory of the father of American entomology, Thomas Say, by the publication of a series of volumes on systematic entomology. These volumes are to be of a monographic or bibliographic character and to deal only with the insects of North America. It is hoped that a series of volumes similar in appearance and of the same high standard as the volumes of the John Ray Society of England can be issued. To this end a temporary committee consisting of J. M. Aldrich and Nathan Banks, U. S. Bureau of Entomology, E. P. Van Duze, University of California, Morgan Hebard, Academy of Natural Sciences of Philadelphia, treasurer, and Alex. D. MacGillivray, University of Illinois, editor, was appointed to solicit funds, and when these are sufficient, to issue such works as they may deem worthy of publication. The most difficult problem confronting the committee is the securing of a fund sufficient for publication. It is hoped that an endowment fund, the income from which will be sufficient for the issuance of about two volumes per year, will eventually be available. Until such a time, however, an attempt will be made to obtain subscriptions for the issuance of volumes.

AWARDS OF THE FRANKLIN MEDAL

The Franklin medal, the highest recognition in the gift of The Franklin Institute of the state of Pennsylvania, has recently been awarded to Heike Kamerlingh Onnes and to Thomas Alva Edison. The awards were made on the recommendation of the institute's committee on science and the arts, that to Onnes being in recognition of his "long-continued and indefatigable labors in low-temperature research which has enriched physical science, not only with a great number of new methods and ingenious devices, but also with achievements and discoveries of the first magnitude" and that to Edison in recognition of "the value of numerous basic inventions and discoveries forming the foundation of world-wide industries, signally contributing to the well-being, comfort and pleasure of the human race."

The Franklin Medal Fund, from which this medal is awarded, was founded on January 1, 1914, by Samuel Insull. Awards of the medal are to be made annually to those workers in physical science or technology, without regard to country, whose efforts, in the opinion of the institute, have done most to advance a knowledge of physical science or its applications. The present awards are the first to be made.

The medal awarded to Professor Onnes was received on behalf by His Excellency, Chevalier van Rappard, minister from the Royal Netherlands government, at the stated meeting of the institute on the evening of Wednesday, May 19, and at this meeting Mr. Edison was the guest of the institute and received his award in person. Following the presentations, an address entitled "Electricity and Modern Industrial Growth" was delivered by Mr. Insull.

SCIENTIFIC NOTES AND NEWS

Dr. Frank J. Goodnow was installed as president of the Johns Hopkins University on May 20. After he had delivered his inaugural address on "Modern Educational Ideals," he conferred degrees on twelve distinguished scholars and scientific men who were presented by Dr. William H. Welch. The scientific men on whom the degree of doctor of laws was conferred are as follows: John Mason Clarke, state geologist and paleontologist of New York; John Dewey, professor of philosophy, Columbia University; Simon Flexner, director of the laboratories of the Rockefeller Institute for Medical Research; George W. Goethals, major general of the United States Army, chief engineer of the Panama Canal; Thomas Hunt Morgan, professor of experimental zoology, Columbia University; Michael I. Pupin, professor of electro-mechanics, Columbia University; Robert Simpson Woodward, president of the Carnegie Institution.

At its annual meeting held on May 12, the American Academy of Arts and Sciences, acting upon the recommendation of the Rumford Committee, voted: "That the Rumford Premium be awarded by the Academy to Charles Greeley Abbott for his researches on Solar Radiation." The committee has appropriated

$140 to Professor Joel Stebbins, of the University of Illinois, in aid of his research with his improved photo-electric cell photometer upon variable stars.

The first award of the Ackermann-Teubner memorial prize in mathematics has been made to Professor Felix Klein.

The British Institution of Civil Engineers has awarded its Telford gold medal to Mr. A. L. Bell (Rosyth); Telford premiums to Mr. C. W. Anderson (Chakradharpur, India), Sir Thomas Mason (Glasgow), Dr. H. F. Parshall (London), and Mr. H. E. Yerbury (Sheffield), and the Crampton prize to Mr. F. D. Evans (Kuala Lumpur).

Professor Sydney J. Hickson has been elected president of the Manchester Literary and Philosophical Society for the ensuing year (1915–16).

The corporation and faculty of Brown University gave on May 24 a complimentary dinner to Professor Nathaniel F. Davis and Professor William C. Poland, heads of the departments of mathematics and art, who next month retire on pension, after over forty years of service.

The Cordilleran Section of the Geological Society of America has elected Professor C. F. Tolman, Jr., of Leland Stanford Jr. University, chairman in place of Dr. H. Foster Bain, resigned, and Mr. Joseph A. Taff, 781 Flood Building, San Francisco, secretary, in place of Professor G. A. Louderback, resigned.

On the staff of associate editors of the *Transactions of the American Mathematical Society*, Professors A. B. Coble and W. A. Hurwitz have succeeded Professors J. I. Hutchinson and Max Mason, who have served since 1902 and 1911, respectively.

H. H. M. Bowman, of the University of Pennsylvania, has been appointed botanical research investigator at the laboratory of the Carnegie Institution on the Dry Tortugas. He will sail from New York for the West Indies on May 29.

Under the auspices of the American Museum of Natural History, Dr. Robert H. Lowie, of the department of anthropology, will leave early in June in order to undertake investigations among the Hopi of Arizona and the Moapa Paiute of southern Nevada.

Dr. F. L. Stevens, professor of plant pathology in the University of Pennsylvania, will be engaged during the summer in a biological survey of Porto Rico, collecting and studying tropical plant diseases and fungi. He will sail June 5 accompanied by Mrs. Stevens and by several students.

From the *Zeitschrift für Angewandte Entomologie* we learn that Dr. Georg Escherich, Forstrat in Isen, was badly wounded by shattering of the tibia near Markirch; Dr. W. Herold, of Greifswald, is in a hospital in Berlin with five wounds; Dr. K. H. C. Jordan, of Neustadt, is in a hospital at Lambrecht; Professor Dr. A. Thienemann, of Münster, has been injured by a shell splinter in the upper thigh and lies wounded at Bonn.

The Paris Academy of Sciences, after considering a report presented in secret committee by M. Adolphe Carnot, has passed a resolution removing from its membership four German scientific men, including Dr. Wilhelm Waldeyer, professor of anatomy, and Dr. Ernst Fischer, professor of chemistry, in the University of Berlin.

It is stated in *Nature* that Mr. J. E. Cullum retires from the post of superintendent of the Valencia Observatory, Cahirciveen, Co. Kerry, Ireland, and that Mr. H. G. Dines has been appointed to succeed him, as from May 1. Mr. A. H. R. Goldie has been promoted senior professional assistant to Mr. Dines at the observatory at Eskdalemuir.

Professor Waterbury, of the University of Arizona, gave on May 12 an illustrated lecture on "Arizona and the Southwest," before the Civil Engineering Society of the University of Illinois. The pictures shown portrayed the development of the reclamation work in Arizona.

The final meeting of the year of the Columbia Sigma Xi, at which the Columbia Chapter of the Phi Beta Kappa was the special guest, was held on May 19. Dr. W. J. Gies spoke on "Diseases of the Teeth and Bones, their Causes and Prevention, with Some Demonstrations."

AT the second annual meeting of the Kentucky Academy of Sciences, Professor Dayton C. Miller, of the Case School of Applied Science, gave a lecture on "The Science of Musical Sound," and was elected an honorary member of the academy. Professor A. M. Miller, of the department of geology, of the Kentucky State University, has been elected president of the Kentucky Academy of Science.

DR. FRANCIS G. BENEDICT addressed the students at Vassar College on Monday afternoon, May 10, on "Investigations in the Nutrition Laboratory of the Carnegie Institution of Washington." In the evening he addressed the advanced students in chemistry and physics and the instructors on "Women as Research Assistants."

AMONG recent scientific lectures before the faculty and students of Oberlin College have been the following: "Business and Kultur," by Professor Arthur G. Webster, of Clark University; "Some Physical Characteristics of the Vowels," by Dayton C. Miller, of Case School of Applied Science; "Recent Evidences as to the Nature of Molecules and Atoms," by Dr. Robert A. Millikan, of the University of Chicago. Dr. Millikan also made an address on "The Significance of Modern Scholarship," this being before the Society of Phi Beta Kappa.

AT the University of Cambridge the Linacre lecture was delivered by Professor E. H. Starling, on May 6, on "The Governor Mechanism of the Heart." The Rede lecture was delivered by Dr. Norman Moore, on the same day, on "St. Bartholomew's Hospital in Peace and War."

WE learn from *Nature* that a monument to the late Professor J. H. van't Hoff was unveiled at Rotterdam on April 17. It consists of a bronze statue, double life-size, in sitting position, and has been placed in front of the school at which Professor van't Hoff was educated. The monument is about 30 ft. high, and the statue itself is flanked by female figures representing "Imagination" and "Reason." On the front of the base is the following inscription:

VAN'T HOFF,
1852–1911.
Physicam chemiae adiunxit.

JOSEPH JOHNSTON HARDY, professor of mathematics and astronomy at Lafayette College, died at his home on May 2. He was born in New Castle, England, in 1844, and came to this country in 1846. He was graduated from Lafayette College in 1870 and immediately became a member of the teaching staff. He is survived by two daughters and a son, James Graham Hardy, now professor of mathematics at Williams College.

WILLIAM JAMES SELL, F.R.S., university lecturer and senior demonstrator in chemistry at the University of Cambridge, has died at the age of sixty-eight years.

ERASMUS DARWIN, the only son of Mr. and Mrs. Horace Darwin, of Cambridge, a grandson of Charles Darwin and of the first Lord Farrer, was killed on April 24 in Flanders. For a time he carried out work in the testroom of the Cambridge Scientific Instrument Company and later became engaged in administrative work.

THE April number of the *Review of Applied Entomology* states that Duncan H. Gotch, entomological assistant in the Imperial Bureau of Entomology, London, was killed in action at Nieuve Chapelle on March 11, while acting as second Lieutenant in the Worcestershire regiment.

MR. SANDERSON SMITH, malacologist, of Port Richmond, Staten Island, N. Y., died on March 28, aged 83 years. He was born in London on May 14, 1832. He studied in the School of Mines, in London. From 1860 to 1870 he published a number of papers in the *Annals* of Lyceum of Natural History of New York, on the Mollusca of Long Island, Staten Island and adjacent islands. From 1875 to 1887 he was one of the volunteer assistants engaged in the various dredging expeditions carried on by the U. S. Fish Commission off our eastern coast, including the deep sea work, and was of great service in that work. Later in life he made extensive collections of maps, charts and engravings. He also compiled, for

the Fish Commission Reports, lists of all the dredging stations occupied by the vessels of the United States and foreign countries, with all the physical data obtained, thus forming a valuable oceanographic work.

A TELEGRAM received at the Harvard College Observatory from Professor E. B. Frost, director of Yerkes Observatory, Williams Bay, Wisconsin, states that two companion bodies have been found by Professor Barnard near Mellish's Comet. One of these was conspicuous, and had a distance of 28″ and a position angle of 285°, on May 12, at $19^h\ 36^m$. The other was faint, and occupied an intermediate position in the same line. A cablegram received at the observatory from Professor Elis Strömgren, director of the University Observatory, Copenhagen, Denmark, states that Delavan's Comet, the discovery of which was recently announced, proves to be Tempel's periodic comet. Ephemerides of this comet, by Strömgren and Braae, are published in *Astronomische Nachrichten*, No. 4792.

DR. WINFORD H. SMITH, superintendent of the Johns Hopkins Hospital, has announced a gift of $16,500, to be paid in three yearly installments, from Mr. John D. Rockefeller, Jr., to be used in a special social hygiene department at the hospital, which is to be established next September. The work of the new clinic will be in charge of a committee consisting of Dr. George H. Walker, chairman, Dr. Theodore C. Janeway and Dr. Winford H. Smith. Dr. Albert Keiden, a graduate of the Johns Hopkins Medical School, will be the physician in charge of the new dispensary. He will have four assistants.

ON account of the unfavorable state of the finances of the country, due mostly to the European war, the Peruvian government has ordered the closing of the Museum of the National History and Archeology at Lima. This action is much to be regretted, for the archeological part of the museum was, in many respects, the most important in South America.

THE annual meeting of the German Surgical Association was supposedly postponed on account of the war, but we learn from the *Journal* of the American Medical Association that the surgeon-general of the army sent out a summons for the meeting to be held at Brussels. Hundreds of surgeons attended the meeting, which commenced at Brussels on April 7. All the sessions were devoted to military surgery and a number of new points learned from practical experience were brought out. Drs. Garré, Körte, Payr and Bier delivered the leading addresses.

THE fortieth annual meeting of the American Academy of Medicine will be held in San Francisco, June 25 to 28, under the presidency of Dr. John L. Heffron, of Syracuse, N. Y. The sessions will be held in the Auditorium Hall of the Panama-Pacific Exposition. The program will include addresses by the president, Dr. Woods Hutchinson, and Dr. David Starr Jordan. Dr. Jordan's address will be on the Relation of Medicine to the Peace Movement.

THE glass used in this country for the manufacture of lenses is practically all imported except in the case of some of the smaller and cheaper lenses. For several years past, the Bureau of Standards, of the Department of Commerce, has been endeavoring to persuade the glass manufacturers of the United States to take up the manufacture of this material, but they have been unable to do so, partly because of the limited quantity used as compared with other glass, but largely on account of the varying composition required and the difficulty of annealing the glass, as good optical glass must be entirely free from strain. With a view to working out some of the underlying problems sufficiently to enable manufacturers to start in this matter, the Bureau secured two years ago an expert interested in the composition and testing of optical systems, and a little later secured another man skilled in the working of glass to the definite forms required by the theory. These steps were taken first, partly because it is exceedingly difficult to find men having these qualifications, put principally because as the work of experimental glass making progresses, the glass must be put in the form of lenses and prisms to test; in other words, the

Bureau had to be in a position to examine the product as it was made experimentally. In July, 1914, a practical glassmaker was added to the force of the bureau. He is a college graduate of scientific training but skilled in the manipulation of furnaces, and is the sort of a man to make progress at the present stage of the work. Small furnaces were built and melts of a few pounds of ordinary glass were made in order to become more familiar with the technical side. A larger furnace has just been completed which will handle melts of 25 to 50 pounds. The bureau is now making simple glasses according to definite formulas, studying the methods of securing it free from bubbles, and other practical points. This is to be followed by an investigation of the method of annealing. Several glass manufacturers have visited the bureau already for suggestions as to the equipment for the manufacture of optical glass.

In connection with the election of a new president it is stated editorially in the *British Medical Journal* that the Royal College of Physicians of London has had ninety-seven presidents since Henry VIII., in the tenth year of his reign, granted a charter of incorporation. In granting this charter he said that his main reason was to check men who professed physic rather from avarice than in good faith, to the damage of credulous people; accordingly, after the example of other nations, he had determined to found a college of the learned men who practised physic in London, in the hope that ignorant and rash practitioners might be restrained or punished. The charter was granted to John Chamber, Thomas Linacre, Wolsey, Archbishop of York, and others. The college so constituted first exercised its privilege of electing a president by choosing Thomas Linacre for that office in 1518. Down to 1876, when Sir George Burrows ceased to be president and was succeeded by Sir James Risdon Bennett, a graduate of Edinburgh, the president had always been a graduate of Cambridge or Oxford. Since the spell was broken the presidents have all been graduates of the University of London, with the exception of Sir Andrew Clark, who was a graduate of Aberdeen, and Sir William Church, who is a graduate of Oxford. The new president, Sir Frederick Taylor, elected March 29, the day after Palm Sunday, according to the statutes, is a graduate of London, having taken the degree of M.D. in 1870. He became a fellow of the college in 1879, was an examiner at various periods from 1885 to 1896, was on the council from 1897 to 1899, and was censor in 1904, 1905 and 1910. He has been the representative of the college on the senate of the University of London since 1907. He gave the Lumleian lectures in 1904 on "Some Disorders of the Spleen," and was Harveian orator in 1907. He is physician to Guy's Hospital; his predecessor, Sir Thomas Barlow, was physician to University College Hospital. Sir Richard Douglas Powell, who was president from 1905 to 1910, was physician to the Middlesex Hospital; his predecessor, Sir William Church, was physician to St. Bartholomew's Hospital; Sir Samuel Wilks, who preceded him, was physician to Guy's Hospital. Sir J. Russell Reynolds, who was president from 1893 to a few months before his death in 1896, was physician to University College Hospital; Sir Andrew Clark, who preceded him, was physician to the London Hospital; and his predecessor, Sir William Jenner, was physician to University College Hospital. At the present time the treasurer, the Harveian librarian and the registrar are members of the staff of St. Bartholomew's Hospital. The longest tenure of the office of president was that of Sir Henry Halford, who was president from 1820 to 1844. The office is an annual one, but is, as a rule, held for five years.

The proposed expedition to Paris of the University of Pennsylvania unit of physicians and nurses who will devote July, August and September to work in the American Ambulance Hospital, will sail early in June for France. Headed by Dr. J. William White, the party will be made up as follows: Surgeon, Dr. James P. Hutchinson; neurologist, Dr. Samuel J. McCarthy; assistant surgeons, Dr. Edmund P. Piper, Dr. Walter S. Lee, Dr. Arthur G. Billings and Dr. Peter McC. Keating; bacteriologist, Dr. Samuel Goldschmidt Gir-

vin, fellow in research medicine, University of Pennsylvania; nurses, Mrs. M. E. Spry, long chief clinic nurse of University Hospital; Miss Jackson and Miss Wagner; anesthetist, Miss Frazer. Explaining the undertaking and its purpose, Dr. White said: "In the early winter the executive committee of the American Ambulance Hospital decided, in the interests of medical science and teaching, and for the purpose of increasing the efficiency of the hospital in the case of large numbers of wounded, to invite certain American universities to send staffs from their respective medical schools to take charge of a floor of 150 beds for periods of three months each. The Western Reserve University took the term of January, February and March; Harvard, April, May and June, and is now on duty. Pennsylvania accepted for the earliest period she could obtain, viz., July, August and September. The other institutions invited were Johns Hopkins and the University of Chicago, which are expected to follow in the order named.

UNIVERSITY AND EDUCATIONAL NEWS

The Circuit Court of St. Louis has confirmed the will of James Campbell, who left his entire estate to St. Louis University School of Medicine subject to a life tenure of his wife and daughter. His estate is valued at from six to ten million dollars.

The late Ward N. Hunt, of Needham, Mass., has made Dartmouth College residuary legatee for $20,000, to establish scholarship funds to be known as the Hunt scholarships.

It is stated in *Nature* that the Hutchinson Museum has been acquired by the Medical School of the Johns Hopkins University. The collection comprises original colored drawings; colored plates taken from atlases, books and memoirs; engravings, woodcuts, photographs and pencil sketches, in some cases with the letterpress or manuscript notes attached. The collection illustrates the whole range of medicine and surgery, but particularly syphilis and skin diseases.

Sir Joseph Jonas has given the University of Sheffield £5,000 to found a laboratory in connection with the applied science department, for testing metals and minerals, especially those involved in the production of steel.

Dr. Henry Suzallo, professor of the philosophy of education in Teachers College, Columbia University, has been elected president of the University of Washington.

Dr. Hermon C. Bumpus, formerly professor of zoology of Brown University and director of the Museum of Natural History, will be installed as president of Tufts College on June 12.

At the University of Oklahoma, Professor F. C. Kent has resigned, and Dr. H. C. Gossard has been appointed instructor in mathematics.

Dr. Moyer S. Fleisher, who has been assistant in the department of pathology of the St. Louis Barnard Free Skin and Cancer Hospital, has been made assistant professor of bacteriology in the St. Louis University School of Medicine.

Dr. Samuel H. Horwitz has been appointed instructor in research medicine in the Hooper Foundation for Medical Research of the University of California, San Francisco.

DISCUSSION AND CORRESPONDENCE

ZOOLOGISTS, TEACHERS AND WILD LIFE CONSERVATION

To the Editor of Science: In spite of the fact that we are familiar with the idea of historic cycles, it is a constant surprise, in watching advances in thought and action, to see that they are usually made not only without the cooperation, but often even with the opposition of those vitally concerned. This is true not only of the prophets of national defense, but is equally so of the protection and conservation of wild life. Strange as it may seem, the most experienced and best informed leader of this movement in this country states that the very people from whom every one should naturally expect the heartiest support—the professional zoologists and teachers of zoology—have been practically a negligible quantity in this defensive and constructive movement. Why is this true? There appears to be some fundamental weakness in this position. Can a factor in the problem be that we have become so engrossed in important

laboratory activity and in domestic animals that there is little interest and concern about wild life? Professor W. K. Brooks once said:

Is not the biological laboratory which leaves out the ocean and the mountains and meadows a monstrous absurdity? Was not the greatest scientific generalization of your times reached independently by two men who were eminent in their familiarity with living things in their homes?

Certainly Hornaday's "Wild Life Conservation in Theory and Practise" (1914) is a volume which should be read by every student of zoology and by all interested in general conservation problems. It is the outcome of a course of lectures given to the students of forestry at Yale, and is clearly an effort to enlist the interest and intelligent support of a *younger* generation of men, as it is on them that the hope for future progress largely depends. Hornaday clearly and forcibly shows the strenuous efforts which have been made in protecting our wild life from the plume hunters and the ordinary ignorant and selfish hunters of all kinds.

To bring out the sound rational foundation upon which protection is based, the economic value of birds is presented to show how they reduce the excessive numbers of insects in fields, orchards and forests, and the aid which hawks and owls give in helping keep down the number of vermin. The proper use of game is shown to be capable of producing millions of dollars worth of valuable food, as well as furnishing recreation for many people. Some of the New England states have already begun to profit by this on a large scale. In his enthusiasm for the cause of protection Hornaday does not go to the extreme and ignore the harm done by certain kinds of animals, or even occasional harm by kinds usually neutral or beneficial. The whole discussion is eminently sane and judicious.

Hornaday makes a strong appeal to the citizen not to allow a few people, a special class, who are reckless in the destruction of animals, and who really care nothing for their obligations to future generations, to advance unhindered in their devastation of our valuable fauna, which, if once lost, can never be restored. He says:

Seventy-five per cent. of the men who shoot game in America, in Europe, Asia and Africa are thoroughly sordid, selfish and merciless, both toward the game and toward posterity. As a rule, nothing can induce any of them to make any voluntary sacrifices for the preservation cause. They stop for nothing, save the law.

Such a view will appear strange and extreme to many, but at the same time it is, to some degree, a measure of one's familiarity with this aggressive campaign. And what will zoologists think of this statement?

And think, also, what it would mean if even one half the men and women who earn their daily bread in the field of zoology and nature study should elect to make this cause their own! And yet, I tell you that in spite of an appeal for help, dating as far back as 1898, fully 90 per cent. of the zoologists of America stick closely to their desk work, soaring after the infinite and driving after the unfathomable, but never spending a dollar or lifting an active finger on the firing line in defense of wild life. I have talked to these men until I am tired; and the most of them seem to be hopelessly sodden and apathetic

While this is equally true of educators at large, the fact is they are *far* less to blame for present conditions than are many American zoologists. The latter have upon them obligations such as no man can escape without being shamefully derelict. Fancy an ornithologist studying feather arrangement, or avian osteology, or the distribution of sub species, while the guns of the game-hogs are roaring all around him and strings of bobolinks are coming into the markets for sale! Yet that is precisely what is happening in many portions of America to day, and I tell you that if the birds of North America are saved, it will not be by the ornithologists at large. But fortunately there are a few noble exceptions to this ghastly general rule.

This quotation is not given to antagonize zoologists, but in the hope that some of their lethargy will be thrown off. If any one doubts the truth of this statement and resents it he is just the sort of person who should read this book. To the open-minded individual who has given no attention to this subject this book will be a revelation. The last chapter is replete with valuable practical suggestions for future constructive protective work. Repeatedly in this book important plans for the

future are outlined, such as the *conversion of our national forests into game preserves.* It is encouraging to know that there are already three endowments devoted to animal protection, one of $340,000, a second for $51,000 and a third of $5,000. Of course these funds should be greatly increased as the period of relatively easy conquest is now over and the opposition is organized with powerful financial support. This contest is a permanent obligation.

The two concluding chapters of the volume are contributed by F. C. Wolcott. One is a valuable summary of the present status of private game preserves, and the other is a very useful bibliography on preserves, protection and the propagation of game.

With this volume and Hornaday's "Our Vanishing Wild Life" (1913) any intelligent person can become informed upon the present status of this phase of conservation.

Chas. C. Adams

New York State College of Forestry,
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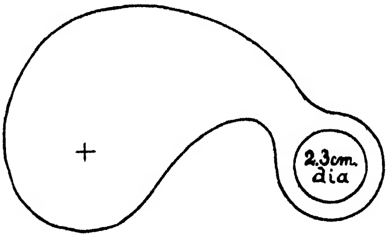
AN EYE SCREEN FOR USE WITH THE MICROSCOPE

Most beginners, as well as many practised observers, usually close one eye when using the microscope. This practise of "squinting" when one is using the microscope for any length of time causes a decided eyestrain. The other alternative of keeping both eyes open requires first of all considerable practise, and if it does not tend to strain the muscles of the eyes, it does give rise to a mental strain, if it may be so expressed; *i. e.*, one has to concentrate his attention constantly on what is seen with the one eye through the microscope, otherwise the objects seen with the other eye will prove very distracting.

The writer, after having tried many different shapes and kinds of eye screens, has worked out one that seems to be the most efficient. It does away with the eyestrain of both types described above, and is very simple and inexpensive.

The accompanying sketch shows the outline of the screen. The material from which it is made is a composition called "vulcanized fiber board," 1.5 mm. in thickness and black in color. This composition board is very tough and durable. It may be obtained from the Diamond State Fiber Company, Ellesmere, N. J. The screen is cut from this board with a knife or with heavy shears. A hole 2.3 mm.



in diameter (a hair larger than the outside diameter of the standard eyepiece) is bored by means of an extension bit at one end of the screen. The distance from the center of this hole to the middle point of the broad wing of the screen is 8 cm. The extreme length and width of the screen is 12.5 cm. by 7.5 cm.

If the composition board is not available, aluminum 1 mm. thick, painted black or dark green on both sides, will be found a good substitute.

The eyepiece of the microscope is slipped through the hole in the screen. The sketch shows the eye screen in position for use with the right eye, and to change to the left eye it is a matter of only a few seconds to take the screen from the eyepiece and invert it.

It will be found that the black surface of the screen is very restful to the eye not in use, and when one alternately uses the right and left eye, it is possible to use the microscope for a much longer period before the eyes become tired than without the eye screen.

Orton L. Clark

Mass. Agr. Experiment Station,
Amherst, Mass.

EXHIBITION OF THE ROYAL PHOTOGRAPHIC SOCIETY

To the Editor of Science: The Royal Photographic Society of Great Britain is holding its sixtieth annual exhibition in August and September of this year. This is the most representative exhibition of photographic work

in the world, and the section sent by American scientific men last year sufficiently demonstrated the place held by this country in applied photography. It is very desirable that American scientific photography should be equally well represented in 1915, and, in order to enable this to be done with as little difficulty as possible, I have again arranged to collect and forward American work intended for the scientific section.

This work should consist of prints showing the use of photography for scientific purposes and its application to spectroscopy, astronomy, radiography, biology, etc. Photographs should reach me not later than Thursday, July 1. They should be mounted but not framed.

I should be glad if any worker who is able to send photographs will communicate with me as soon as possible so that I might arrange for the receiving and entry of the exhibit.

C. E. K. MEES

RESEARCH LABORATORY,
KODAK PARK,
ROCHESTER, N. Y.

SCIENTIFIC BOOKS

Report on Gyroscopic Theory. By SIR GEORGE GREENHILL. Reports and Memoranda, No. 146, Advisory Committee for Aeronautics. London, T. Fisher Unwin, 1914. Pp. iv + 278, with 49 illustrations. Price 10 shillings.

Many people wonder at the expenditure of time and energy given by the mathematician to subjects like the theory of groups and differential equations. Others can not understand why men of the ability of Klein, Perry and Crabtree should lecture upon the theory of the top. Still others fail to see in the studies made by Maxwell of his spinning top in an agate cup, or of Sommerfield and Noether on the gyroscope, anything to justify a student in following in their footsteps. And yet, when we reflect that the spinning top illustrates a group of motions, that its theory involves the differential equation at the very outset, that the earth is merely a moderate-sized top spinning in space, that the solar system is a somewhat larger one, and that many nebulæ are solar systems in formation, the subject assumes a different aspect, even to the man in the street. And when he further reflects that the stabilizing gyroscope, now made in large numbers by Sperry's company, is used on the aeroplanes above the firing lines in the great war, and acts as a literal balance wheel on the super-dreadnoughts of the warring powers and can be bought in the offices of the makers in any of the large capitals of the world, this same man in the street begins to see that the theorist may touch upon the very practical and that the practical man may well afford to look to the man of theory for help in the affairs of the real life of the present day.

It is such popular considerations as these that may well lead the man of dollars to welcome, even if he can not understand, a monumental treatise like this which Sir George Greenhill, with his usual modesty, has called a simple report. To the general man of science the work will mean much more, even if he too shall fail to read 278 large quarto pages devoted chiefly to mathematics. But to students of analytical mechanics, and particularly to those who look for applications of modern mathematics to dynamics, the work will stand as a monument of patient research on the part of a man who works *con amore* and with an extended vision in a field of rapidly increasing importance.

Sir George Greenhill always writes as he talks, and he never talks like the man whom he delights to refer to as "a mere mathematician." As he sits at the head of a work table in his quaint room in Staple Inn—the room in which Dr. Johnson may have written Rasselas—and talks of his labors on the gyroscope, he is a mathematician for about a minute, a man with the zeal of a boy for another minute, a charming raconteur of stories of his master, Maxwell, the minute later, and an appreciative student of his friends Klein and Sommerfield in the next unit of time. And this description characterizes his addresses, his books, his memoirs and his reports—they are all human, the product not merely of the mathematician, not merely of the student of dynamics, not merely of the experimenter in the laboratory, but always of the big-hearted man.

And so it is with this report. It is filled with mathematics in which elliptic functions, long a favorite study of Sir George's, plays an important rôle; but the reader is continually running across such homely illustrations as those a teacher might use in the classroom—the illustrations of bicycle wheels, stepladders, clock hands, reflections in a mirror, plumb lines, balancing on a knife edge, tops, children's hoops, race wheels, motor cars, the motor omnibus, spinning cards through the air, Whitehead torpedoes, the monorail carriage, and the like—just the sort of things that those who have used the problems in the author's calculus have delighted to find for interesting a class.

The report is divided into nine chapters. Chapter I. relates to steady gyroscopic motion, with applications to the problem of the precession of the equinox and to the gyroscope as a stabilizer. Chapter II. continues the applications of the gyroscope, in particular with reference to ships, the Brennan monorail carriage and the Bessemer saloon. Chapter III. relates to the general unsteady motion of the gyroscope, and to the figures resulting therefrom—for example, to the rosette curve described by Klein. Chapter IV. deals with the geometrical representation of the motion of a top, and in particular with the work of Darboux. Chapter V. treats of the algebraic cases of top motion, and in particular of the section problems, a subject continued in Chapter VI. Chapter VII. relates to the spherical pendulum and related topics, Chapter VIII. to such topics as the gyroscope on a whirling arm, and Chapter IX. to the dynamical problems of steady motion and small oscillation.

It is not intended in this brief review to do more than call attention to the general nature of the work. The practical value of the subject has come to be recognized in this war as never before, and it is well that we have in one place the body of theory which students of the subject would otherwise have to search for in many pamphlets, books and periodicals. The report lays no claim to any important discovery, but it may fairly claim to bring together in convenient form the mathematical theory of the gyroscope as far as it has been developed up to the present time.

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Monographs on Biochemistry. Soil Conditions and Plant Growth. By EDWARD J. RUSSELL, D.Sc. (Lond.), Director of the Rothamsted Experimental Station, Harpenden; with diagrams. New Edition. Longmans, Green and Co., 1915. Pp. 150.

This is the third edition called for within three years of the best book on the soil which has yet been written. A new chapter has been added on "The Relationship between the Microorganic Population of the Soil and the Growth of Plants." A number of minor changes and a few of considerable importance have been made in the original text, usually because of recognition of literature nonexistent when the text was prepared originally. The versatility of Dr. Russell is astonishing and the wealth of his information is prodigious. And yet he has told his story in some 170 pages without an undue crowding. In fact the book has "charm" and is easily read. The professional chemist, physicist and bacteriologist will find it a mine of information most interestingly woven together, but with frequent references to original authorities. And at the same time the layman can get a purview of the complex system involved in plant production in an understandable story.

Not only is the book the best in its field relatively, but it is very good absolutely. But it is not ideal, and probably most of the experts will feel that its accents should be altered and even that some of the statements should not have been made as they are. For instance, the reviewer should prefer to see the relation between moisture content and the measurable physical properties of the soil given more prominence; and the dynamic as contrasted with the static properties of the soil developed more definitely. One is left with a too hazy idea of the colloidal properties of clay and their importance to the soil, and the purely hypothetical calcium bicarbonate is called upon rather frequently to explain things without

the slightest intimation that its claims to existence are any less valid than any other compound. It is stated that the water in the soil is weakly held, when as a matter of fact the film moisture is held by probably enormous stress and the reader is left in confusion as to just what the author means. It is not the simplest view (page 77) that the mineral particles are coated with a colloidal complex, but that the so-called colloidal properties of the soil are those resulting from the relatively vast surface presented by the "clay" portion of the soil; and it would be more satisfactory to utilize the fact that the solubility of calcium carbonate is increased by increasing the partial pressure due to carbon dioxide than assume the existence of a compound which can not exist at any gas pressures existing in the soil.

But when there is so very much that is admirable it makes one feel ungracious to continue criticisms of details. The book deliberately makes its major appeal to biologists, and the greater part of the text is devoted to the biological properties of the soil. But its most striking feature is the skilful handling of the contrasting views of soil chemists and physicists. While it is probable that others as well as the reviewer will not entirely agree with the author's presentation of recent controversies, every one will undoubtedly recognize the evident intent of fairness and careful effort to summarize correctly. It is very probable that no one could at this time make a better presentation than has Dr. Russell, although we may each hope that some future edition of his book may accord more closely with our several individual views. Fortunately for the development of this branch of applied science, modification of the personal views of most of the prominent workers is commendably frequent and frank. A satisfactory index and a well-selected bibliography are retained in the present edition.

Dr. Russell's monograph is not suited to class-room use of undergraduates in our agricultural colleges, though such undergraduates would undoubtedly profit by reading it. The book will prove a mine of suggestions to the advanced scholar and investigator and should prove an eloquent testimony for the view that the time has now come when our universities can afford to recognize that some agricultural subjects have developed to a point in dignity of effort and scholarship where they might profitably be included in the curriculum beside older and more familiar academic fields. The advances of the last few years in secondary rural education and in the standard of our American agricultural colleges is worthy cause of gratification. But it is almost a disgrace that our principal universities are utterly failing to train and provide leaders and teachers for what must always be our country's chief field of endeavor; and to recognize that the art of agriculture is passing—rapidly passing in the United States—from the avocation of the artisan to the profession of the highly trained specialist. Dr. Russell's book will not be the least of the instruments to bring about the change.

Frank K. Cameron

SHARK INTOXICATION[1]

The flesh of the economically very important Greenland shark (*Somniosus microcephalus*), a shark usually between 6 and 14 feet in length occurring abundantly in the Arctic Ocean and ranging southward to Norway, the Faeroes, Iceland, Cape Cod, Oregon and Japan, has long been known to possess certain poisonous qualities.

It is not known to what extent the poisonous nature of the flesh of this fish is shared by that of other species of sharks, some of which, at least, appear to be quite harmless; but in view of the possibility that in the near future the flesh of some of our more abundant species of selachians may be placed on the market for the purpose of providing a cheap supply of good fresh food, it would seem opportune to call attention to what is known in regard to the undesirable qualities of the flesh of the Greenland shark in order that similar qualities in the flesh of other species, if present, may be immediately detected.

Mr. Ad. S. Jensen, of the zoological museum of the University of Copenhagen, has re-

[1] Published with the permission of the secretary of the Smithsonian Institution.

cently published[2] the following excellent summary of all that is definitely known concerning shark intoxication.

In North Greenland, where the dog plays such a large part as draught animal for the sledge, the shark fishery has the additional importance of providing food for the dogs. In the dried condition especially shark flesh is an excellent dog food; it gives the animals strength to sustain prolonged exertions without being fatigued. In the fresh condition, on the other hand, it is dangerous for the dogs; when they eat a quantity of it they become heavy and subject to giddiness (they are said to be "shark-intoxicated"); on driving a short distance with them they begin to hang their ears, tumble from side to side and at last fall down in cramp convulsions, after which they can not be got to move from the spot; in a couple of minutes the dog may recover, but when it runs again the whole body quivers and the dog has no power to drag; at the same time, especially when the weather is warm, the animal has diarrhea, its feces are "squirted out" as greenish water; sometimes the animal dies of the sickness. At places where shark food is plentiful, however, the dogs accustom themselves to eating a large amount of it without being sick; but if they are driven in the warm sunshine they may be very bad from it. From dried shark flesh the dogs never become "shark-intoxicated," yet they can also become sick from it, as dried shark meat tends to swell out in the stomachs of the dogs; the Greenlanders therefore advise to give the dogs only small rations of dried shark meat and first to cut the meat into long and narrow strips, so that the dogs do not gulp down the whole at once, but can regularly work through it with the teeth.

To explain these phenomena it may be said that the fresh shark flesh contains a compound that acts like alcohol; when the flesh is boiled, the poisonous stuff is removed and the dogs can then eat more of it without suffering than when the meat is fresh. The poisonous substance is probably present everywhere in the body of the shark, also in the cartilage. Rink was of the opinion that the danger of the shark's flesh was due to its containing a large amount of saline fluids, which were totally swallowed down when the flesh was eaten in the frozen condition. To clear up the matter I consulted the veterinary surgeon S. Hjortlund, who lived for a couple of years in North Greenland and there made investigations on the infectious sickness of the dogs; he has kindly sent me the following information.

"These cases of poisoning, which in Greenland always occur after eating fresh, raw meat of the Greenland shark (*Sominosus microcephalus*), both in men and dogs, is without doubt due to a specific poison (a toxin) which occurs in its body. Nothing indicates the correctness of Rink's view, that the poisonous nature of fresh shark meat was due to the large quantity of saline fluids it contained, whilst many things speak against this view.

"Meanwhile, however, the question has not yet been scientifically investigated and all we know about it is exclusively based on empirical observations.

"The clinical symptoms, of which—as mentioned above—tiredness, dullness, uncertain gait, sensory disturbances and a profuse diarrhea are the most in evidence, depend in virulence on the quantity of meat taken, but in dogs can also be intensified in mild weather and with bodily exertion. In men, where the poison causes a similar complex of symptoms, the sense disturbances both objectively and subjectively give the same impression as acute alcohol poisoning. The symptoms of poisoning may last a shorter or longer time, from a couple of hours to a couple of days. They may be very weak, almost unnoticeable, when the animal has only taken a small quantity; on the other hand dogs have several times been known to die under violent symptoms, almost apoplectic in character, a short time after they had eaten large quantities of shark meat.

"Of importance in judging of the nature of the poisonous stuff or stuffs is the fact that the animals can gradually be accustomed to taking larger and larger quantities of it. Obviously antitoxins can be produced in the body of the dog, which counteract the activity of the poison; in other words, the animal can to a certain degree become immune, and this gradually occurs spontaneously at places where the dogs have constantly the opportunity of eating fresh shark meat.

"The poison, however, is soluble in water and can thus be extracted from the meat by thorough washing. How far, on the other hand, it is destroyed by heating to temperatures below 100° is more doubtful. In any case the transformation here must proceed slowly; for according to all reports the meat must be cooked in two to three different waters before one can be certain that it

[2] "The Selachians of Greenland" ("Saertryk af Mindeskrift for Jepetus Steenstrup") pp. 12–14, 1914.

is not poisonous. It is most reasonable to assume that it is resistant to such a temperature.

"The usual method in practise of preparing the shark flesh so that it may gradually lose its poisonous qualities is to cut the meat into thin strips which are hung up to dry in the sun and air; it thus loses its large quantity of water, and gradually its poisonous qualities disappear, so that it becomes a rather good food for the dogs, though it must still be used with caution and preferably mixed with a little blubber.

"Regarding the seat of the poison in the body of the shark we have the most divergent opinions; some assume that it is only in the musculature, others that it is exclusively present in the cartilage and others again that it is chiefly found in the peritoneal and spinal fluids, as it has been found that these fluids produce a severe pain when received in the eye. A proper judgment on these matters, however, will only be obtained by means of a special investigation of the poison, and such at the same time would elucidate its chemical composition, its physiological properties and various biological reactions."

A. H. CLARK

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SPECIAL ARTICLES

THE CROWN-GALL OF ALFALFA

DURING the past two years the writer has been engaged in studies upon the life-history of the organism described by Magnus[1] in 1902 under the name of *Urophlyctis alfalfæ*. It seems best to publish a brief statement of the results so far obtained, pending further studies.

1. The "resting spores" when placed in water cultures develop into sporangia.

2. Within these sporangia are formed motile spores of two sizes; usually one large spore and many small ones are formed in the same sporangium.

3. One or several small spores may become attached to one large one. Only one remains permanently attached. It has not been determined whether or not this attachment is in the nature of a sexual fusion. If so, the large spores and small spores are obviously capable of functioning as sexually differentiated gametes.

4. The motion of the large spore continues after the attachment of the small spore.

5. The small spores, the large spores and the united spores (zygotes?) become amœboid after a period of motility.

6. In the amœboid state, singly or in groups, these bodies may be observed to move on the surface of the host.

7. In infected soil young alfalfa seedlings develop galls in which plasmodia are found.

8. In older galls similar plasmodia are present which ramify through the tissues of the gall. Previous to spore formation the parasite becomes massed in cavities formed by the destruction of the host tissue.

9. The resting spores are formed in these cavities, apparently by division of the parasite into many cells.

10. The content, cytoplasm and nuclei, of the resting spores in the dormant condition, corresponds to that of the plasmodium in the stage immediately preceding spore formation.

The presence of a plasmodium as the vegetative stage of the parasite and the entire absence of a mycelium at any stage suggest that possibly the organism should be removed from the genus *Urophlyctis*.

ORVILLE T. WILSON

UNIVERSITY OF WISCONSIN

[1] Magnus, P., "Ueber in knolligen Wurzelauswuchsen der Luzerne lebende Urophlyctis," *Ber. der Deut. Bot. Gesell.*, 20, 291–96, 1902. One plate.

A PRELIMINARY NOTE ON THE FOOD HABITS AND DISTRIBUTION OF THE TEXAS HORNED LIZARDS

RANDOM examinations of stomach contents, made by various workers during the past forty years, have indicated that *Phrynosoma cornutum*, the Texas horned lizard, is of great economic importance. To determine its status as a valuable animal, an examination of four hundred and eighty-five stomachs has been made. As only a small per cent. of the animals found in the field were captured and killed, several facts—besides the principal one—concerning this animal have been disclosed.

The Texas horned lizard, unlike the other species of the genus, is distinctly not a desert form. Its area of distribution is quite extensive, going northward into Kansas, southward

far into the Mexican table land, and westward into Arizona; but, clearly, the area of its greatest abundance is the north and south strip of Texas known as the Black and Grand prairies. This strip of country includes the cities of Fort Worth, Dallas, Waco, Austin and San Antonio—in fact all of the large cities of the state except Houston and Galveston; and is preeminently the best part from an agricultural standpoint. Within this area, where conditions are at all favorable, the *Phrynosoma* population averages at least thirty to the acre. This is despite the fact that for a number of years these lizards have been captured and sold to visitors from the east.

The life history has not been well worked out, but the newly hatched young begin to appear by the first of August; so that it is safe to say that the ordinary agricultural operations such as spring and fall plowing, do not interfere with the life cycle. The natural enemies are few and unimportant, being mainly road runners and opossums.

The stomachs examined included the following forms: four species of ants; four species of weevils (very few boll weevils); four species of bees (mainly miner bees); eight species of beetles; three species of stink bugs; nymphs of grasshoppers and allied Orthoptera; five species of flies; and a few caterpillars, some of which have not yet been identified. The noxious forms found overwhelmingly outnumbered the useful forms.

Agricultural ants were found in 80 per cent. and stink bugs in 60 per cent. of the stomachs. Neither of these is much subject to the attacks of birds. Obviously this enhances the value of *Phrynosoma.* Incidentally, there was a remarkable consistency or homogeneity in the contents of the individual stomachs. For example, in one case, nearly all of the forms present would be Hymenoptera; in another, nearly all would be Heteroptera, etc. This could mean that individuals acquire a taste for sour food, or fatty food, etc.; or, what is more likely, that the same individual requires from time to time certain special elements in its food.

From the data thus far assembled, it can be safely affirmed that the horned lizards of Texas are of tremendous importance to agriculture in that region; and may, perhaps, play as important a part there as does the common toad in the better watered regions of the United States.

W. M. WINTON

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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SECTION D—MECHANICAL SCIENCE AND ENGINEERING. II

The Highways of Hawaii: H. K. BISHOP.

Before the days of county government, the central government of Honolulu, under the superintendent of public works, improved many highways with first-class water-bound macadam, in many instances with a telford base. Under the county form of government, the county took charge of the maintenance of the roads already built and the construction of all new ones. It is needless to say that this system has proven unsatisfactory and unproductive of good results in general.

In 1910 and 1911, by legislative action, provision was made by the territory, to raise funds by means of a bond issue and to put the work of road improvement under this issue in the hands of a commission, to be known as the Loan Fund Commission. The writer was engaged in September, 1911, by the Hawaii Loan Fund Commission to prepare plans and specifications and to superintend the construction of the belt road improvement on the Island of Hawaii. The belt road, which is the main highway of the island, approximately parallels the coast line at a greater or less distance entirely around the island, a distance of approximately 250 miles.

In the work of improvement on Hawaii, the general plan adopted was to use water-bound macadam with a telford base in the wet sections, and bituminous macadam in the dry sections. It was also planned to give the water-bound macadam a surface application of bituminous material when the macadam had become sufficiently compacted to make such a treatment successful.

The greatest need of Hawaii is some form of territorial aid to the counties similar to that adopted by the majority of the states of the Union. Hawaii is also in need of some form of centrally controlled highway department which will insure the standardization of road work and a

continuity of the policy. The territory is going through practically the same experience that every state in the Union has been through in its road work.

Service Tests on Various Classes of Pavements: H. W. DURHAM.

A solid unyielding foundation is a necessity for all road construction, but type and details are purely a local question. Much unnecessary confusion is caused in road discussion by inability to discriminate between cause and effect and by laying more importance on details of specifications than on the result they obtain.

The only true test is that of service under conditions of actual use. Final selection must be made among a limited number of types and suit a limited number of conditions. Carrying intermediate operations in the problem of selecting road types to extremes of refinement is unnecessary in that the conditions to be satisfied are few, and the final selection must be from among these classes.

Service Tests of Stone Block Pavements in Brooklyn: H. H. SCHMIDT.

About five years ago studies were begun of the various granite pavements in the borough of Brooklyn, with a view to determining, if possible, the causes which created the objectionable features. Observation showed that certain granite blocks polished under traffic, so that they became extremely slippery; some wore down rapidly at the edges, causing the top of the block to become turtle-backed, which made the pavement extremely rough; some blocks were found which disintegrated under traffic, and still others were extremely rough and not well-shaped, owing to the fact that they were made from a granite which had improper cleavage planes. We learned from the service tests of the stones actually subjected to traffic, that the mineralogical composition of the granite, the presence or absence of certain minerals, and the proportions in which they occur, as well as the size of the crystals, all had a direct bearing on its value for paving purposes.

After a conclusion had been reached as to the most desirable granite, a study of the size, dressing and filler was taken up. With the use of a concrete base, the extreme depth of the block was unnecessary, and the depth was therefore reduced from eight to five inches. With modern granite block it is possible to obtain joints averaging from a quarter to three eighths of an inch. The blocks are laid so close together that a considerable area of the blocks touch one another, thus giving stability to the pavement, even without the joint filler. It is unnecessary with the modern granite block pavement to use paving gravel, and the modern practise favors the use of a mixture of tar or asphalt with hot sand, poured into the joints.

Wood Block Pavements: W. P. TAYLOR.

The Value of the Absorption Test on Wood Blocks: GEORGE W. TILLSON.

When municipal engineers were considering the advisability of laying treated wood block pavements some twelve or fourteen years ago, it was uncertain as to just what should be the requirements of the specifications. It was felt that it was necessary to prevent the blocks from decay and also to treat them so that they would be stable under all climatic conditions; that is, they should not absorb so much water as to swell and cause the pavement to bulge, during a wet spell, nor should they shrink too much in dry, hot weather, so that they would become loose.

After careful consideration, it was decided to require an absorption test of the blocks. The test provided that after being dried in a kiln at a temperature of 100° F. for 24 hours, the blocks should not gain in weight more than 3 per cent. during immersion. Pavements were laid under this specification in 1903 and 1904, and on one street with a preservative that did not contain any resin, but was a specially prepared oil. The blocks obtained did, however, conform to the requirements as to weight and absorption. These pavements have been in use 10 and 11 years, without any expansion joint, and have required almost no attention on account of the instability of the blocks. In certain cases where pavements were laid not under the supervision of the city, so that the absorption test was not applied, the pavements did expand to a very considerable extent.

The city of New York is the only municipality of which the writer knows where the absorption test is required, and it is also the only city, in his knowledge, where an expansion joint is not used. The writer firmly believes that with a heavy oil treatment of 20 pounds and a specification requiring an absorption test, as given above, satisfactory results can be obtained without an expansion joint.

Sand Cushion vs. Mortar Bed for Wood Block Pavements: THEODOR S. OXHOLM.

In this country it has been the custom for many years to lay wood block pavement on a concrete base with a cushion of sand or a bed of mortar between the base and the blocks. A sand cushion is intended primarily to smooth out the

roughness and inequalities in the concrete, so that the blocks might rest evenly thereon. Secondly, the yielding surface of the sand permits the roller to press the blocks into it until they present a smooth surface, adjusting the slight inequalities in the depth of the blocks, and thirdly, the sand has a slight resiliency and protects the blocks somewhat from surface wear. The mortar bed performs the same office as the sand as an equalizer of the concrete surface and the surface of the finished pavement, but there the similarity ceases, for, as the mortar gradually sets it forms a hard unyielding bed for the blocks to rest upon, sacrificing resiliency for immobility.

There are two objections in the writer's opinion to the use of a sand cushion. First, when cuts are made for any purpose through the pavement, it frequently happens that weeks and months elapse before repairs are made; during this time, storm water works its way between the blocks and base and disturbs considerable quantities of pavement that will have to be relaid. This is especially noticeable on streets with a considerable grade, and could not occur with a well-set mortar bed. Second, it would seem that even the slight resiliency of the sand cushion would mean the unstable condition of each block with respect to its neighbors, and a consequent lack of support on sides and ends which is of the utmost importance. The one objection to a mortar bed has always been that the mortar has been mixed damp and time must be allowed for it to set hard (three or four days), before traffic could be admitted, whereas wood block pavement on sand cushion can be thrown open for traffic as soon as completed. The writer has overcome this objection by mixing the mortar dry, and allowing it to set as moisture reaches it through the joints which are always of sand. The roller and immediate traffic work the blocks down to their final beds before the mortar sets. Work of this kind has been examined at plumbing cuts and it has been found that the mortar was set up hard, though traffic had been allowed on the new pavement as soon as completed, and the surface was still uniform.

Cement Concrete Pavements: PERCY H. WILSON.

The author states that the basic principle of the modern concrete road goes back to the ancient Roman roads in that the latter involved the use of puzzolana, the cement used by the Romans, while Portland cement is used as a binder in the modern concrete road.

The author emphasizes the following as conspicuous advantages of the concrete road:

Absence of mud and dust.

Roads passable at all seasons.

An even but gritty surface texture which prevents horses and cars from slipping.

A flat crown making every foot of road surface available for traffic.

Extreme durability increasing with age and exposure to the elements.

Imperviousness to frost and heat.

Moderate first cost and minimum maintenance cost.

With the establishment of expansion joints at proper intervals the cracking of concrete road had been practically eliminated, but when cracks do occur they are filled with tar and sand at small expense, this treatment, to all practical purposes and intents, restoring the slab to its monolithic character.

The paper describes structural methods and calls special attention to the importance of using only the best quality of materials, strict observance of specifications and careful workmanship.

Cement Concrete Pavements with Thin Bituminous Surfaces: W. H. LUSTER.

The concrete surface standing exposed to the weather and chance traffic for fourteen days becomes dirty, and before the hot bitumen was applied it was thoroughly cleaned in order to bond the two materials. Cleaning is of the utmost importance, and to that end the concrete was swept first with wire brooms, then with ordinary house brooms and then flushed with water under pressure by means of fire hose, and while the water was flowing was swept in the direction of the flow to the drainage inlets, but even then there remained the cement scum, or laitance, which always forms at the low spots to which it drains, and there hardens; this must be removed, for it is always smooth and no bitumen will adhere to it, and even if it did, it is not a suitable material for road metal, as it is soft and brittle and soon disintegrates under traffic.

The refined tar was applied hot by spraying under pressure from a moving auto truck tank, containing about one thousand gallons. A comparison of area covered with the capacity of the tank showed that the quantity spread was about one gallon to every three square yards. The bitumen was then covered with a coating of fine quartz gravel, the largest size grain being three eighths of an inch in diameter, and spread in the proportion of one cubic yard to one hundred square yards of surface. The street as thus pre-

pared was closed for twenty-four hours, after which traffic was admitted.

This thin bituminous coating acts in four capacities: First, it waterproofs the surface; second, it acts as a carpet and deadens the noise of traffic; third, it affords good foothold for horses, and fourth, it prevents abrasion of the concrete, thus prolonging its life.

Topeka Bituminous Concrete Pavements Constructed with Tar Cement: PHILIP P. SHARPLES.

The Topeka bituminous concrete is shown to be a revival of types of pavements laid with coal-tar cement twenty-five years or more ago.

The vulcanite pavements of Pittsburgh and tar concrete pavements of New England are described and compared with Topeka specifications.

The precautions necessary to secure successful work with the Topeka specification using coal tar cement are given.

Bituminous Pavements with Two or More Layers of Bituminous Concrete: ARTHUR H. BLANCHARD.

In cases where one product of a stone-crushing plant is used for the aggregate of the wearing course of a bituminous concrete pavement and this product is composed of broken stone varying but little in size, let us say from ¾ in. to 1¼ in., it will be advisable to use two layers of bituminous concrete. If the above product was used for the first layer and was constructed with a compacted thickness of from 1¾ to 2 inches, the second layer might properly be composed of broken stone from ⅛ to ½ in. in size and spread about ½ in. to ¾ in. in thickness. After the second layer had been rolled the pavement could be finished with or without a seal coat of bituminous cement and a dressing of uncoated stone chips. This method is suggested in order to secure with the above type of broken-stone product a surface of the wearing course which will be as dense as when a product ranging in size from ⅛ inch to 1¼ inch is used and the pavement finished with a seal coat of bituminous cement and stone chips.

From a historical standpoint it is of value to note that an English bituminous pavement of similar type was described in the *Engineering Record* of July 23, 1898. The fundamental principles involved have been made use of in the many successful bituminous concrete pavements constructed in England during the past fifteen years under the trade names of Tarmac and Quarrite.

Bituminous Macadam Pavements (Penetration Method): FREDERICK STEELE STRONG.

In determining the quantity per square yard of bituminous material to be used in construction of a bituminous macadam pavement there are four paramount functions to be considered: First, the nature and consistency of the bituminous material; second, the quality of the stone; third, the depth and sizes of the course; fourth, the kind of traffic and severity of climatic conditions.

With this data, the following equation has been deduced for the proper amount of binder to be used in cases where the stone is of low crushing and abrasive strength, this classification not to include any stone which is so poor as to be questionable or worthless. Let Y represent the number of gallons to be used per square yard. Let X represent the depth of the top course in inches. Then $Y = 9/10\ X$. For instance, with stone of low test, and depth of stone of 2 in., we determine that the quantity of binder should be approximately 1.8 gals. per square yard; and by using this equation again, it is found that for a depth of 3 in. the amount of bituminous material should be 2.7 gallons per square yard.

This binder is to be applied in two applications, the first to be two thirds the full amount and the second the balance, and the application is made by pressure machine. I believe no top course for a road of this type should be less than 3 in. in depth. The best stone available should be used even if its cost would entail the use of cheaper material in bottom course, but by this I do not depreciate the importance of a foundation, as without this any road is worthless.

Some Ways to Differentiate between Bitumens: GEORGE P. HEMSTREET.

The Present Status of Adhesive and Cohesive Tests of Bituminous Materials: JOHN S. CRANDELL.

During the past year the writer has made a series of tests to determine the binding values of a number of bituminous binders. The first tests were made as follows: Cylindrical briquets 25 mm. high × 25 mm. diameter, composed of stone, sand, filler and binder were molded under a pressure of 500 kilos per square inch, or 750 kilos per square inch, and were then allowed to season. They were then tested in the small Page Impact Machine that is used for the cementation test of stone. The number of blows required to break or crush each briquet was recorded. Different percentages of the ingredients were tried. It was found that pieces of crushed stone were cracked while in the molding machine. Other mechanical

difficulties developed, and it was decided to increase the size of the briquets to 35 mm. high × 50 mm. diameter. No difficulty is now found in molding the specimens.

These tests, which the writer has called binding value tests, furnish (*a*) an easy means of comparing the adhesive and the cohesive strength of binders, (*b*) a control of the amount of binder to use, and (*c*) a quick way of determining the correct amounts of stone, sand and filler to use.

The Purchase of Asphalt and Asphaltic Cement on the Bitumen Basis: W. H. Broadhurst.

To those familiar with the nature and composition of asphalts and asphaltic cements, the advantages from an economic standpoint of purchasing these materials on the bitumen basis is obvious. The bitumen, or carbon-bisulphide-soluble content of an asphalt, being the cementitious material which binds the mineral aggregate of an asphalt pavement or bituminous concrete together in a compact mass, it follows that, without giving consideration to the character of the insoluble material, or whether the same improves the value of the asphalt as a paving material or is deleterious, the greater the percentage of the insoluble material, the less the efficiency of the asphalt in respect of the number of square yards of roadway per ton of asphalt a given asphalt or asphaltic cement will lay. Hence to place all asphalts in competition on an economically sound or even basis, the same should be bought on the basis of the contained bitumen. Specifications for the purchase of asphalt should therefore be drawn outlining the requirements, first as to quality, and secondly, as to quantity of contained bitumen, instead of requesting merely bids for refined asphalt, or asphaltic cement, which is a very prevalent custom to-day with many municipalities operating municipal asphalt repair plants and state highway commissions purchasing asphaltic cement for state roads.

A Change in the Asphalt Pavement Specification: John Martin.

Allowable Maximum Penetration of Various Types of Asphalts for Use in the Several Kinds of Bituminous Pavements: H. B. Pullar.

The writer would state that in his own opinion there is no set rule which can be adopted or followed in setting a maximum penetration for any type of asphalt or any type of bituminous construction; that it is necessary to consider the local conditions in conjunction with the various bituminous materials on the market and to incorporate them in such a way into the specifications so as to get most satisfactory results. The writer further believes that the maximum penetration is merely one of the many small but important details of construction which must be considered separately for each different piece of work, and that in order to get bids on bituminous materials specifications should be so drawn with limits sufficiently open to produce maximum competition with reverting specifications on bituminous materials, these reverting specifications to be drawn up with limits narrow enough to exclude anything but the highest quality of material for that particular type of bituminous material and at the same time not be unjust to the producers of the different kinds of bituminous materials. Under this kind of a specification it is possible to take into consideration all of the local conditions, the different characteristics, and the inherent qualities of the different bituminous materials and to incorporate in these specifications the allowable maximum penetration for the particular type of pavement and under the particular conditions it is to be constructed, and the writer believes that it is only by this method that the most successful results can be obtained.

A Review of the Use of Bituminous Materials in Highway Engineering during 1914: Arthur H. Blanchard.

During 1914 the following noteworthy developments have been noted:

In specifications for bituminous materials there has been a tendency to adopt a group of type specifications in place of a blanket specification. By this method engineers have been able to secure the most suitable grade of a given type of bituminous material for a given method of construction, as it is practicable to specify desirable limits for each type rather than have wide limits, as is necessary in blanket specifications. Another self-evident advantage is that more uniform material may be secured by this method.

Bituminous surfaces have been constructed (*a*) with more attention to the physical properties of the road metal composing the wearing course and the requisite dryness and cleanliness of the surface prior to application of the bituminous material; (*b*) using to a greater extent bituminous materials which do not require from several days to three weeks to set up; (*c*) generally employing pressure distributors in place of hand methods and gravity distributors.

In the construction of bituminous macadam pavements there has been a noteworthy tendency to (*a*) use bituminous cements of a lower penetra-

tion than formerly and (*b*) more thoroughly roll the wearing course prior to the first application of bituminous material.

Bituminous concrete pavements have increased in popularity in many sections of America. There has been a general tendency to use carefully heated aggregates and employ mechanical mixers. Bituminous materials of lower penetration than formerly are used in bituminous concrete, the aggregate of which is composed of one product of a stone-crushing plant, the sizes of stone ranging from ¼ in. to 1¼ in. The largest contract for this type of construction during 1914 was the Ashokan Highway, 37 miles in length, built by the board of water supply of New York City.

The third session was held on the morning of Thursday, December 31, Vice-president Dr. Frederick W. Taylor and Mr. O. P. Hood in the chair, with an attendance of about 70. The program of the session was as follows:

Vice-presidential Address: *Safety Engineering:* O. P. HOOD.

Engineering and Industrial Regulations for Promoting Safety in Industrial Establishments: JOHN PRICE JACKSON.

Recent Developments in Precise Leveling: WILLIAM BOWIE.

There should be in each city and state and throughout the whole country connected systems of leveling to form the basis and give the datum for the ordinary spirit or wye leveling.

The nation has, at present, about 31,000 miles of precise leveling with more than 13,000 substantial bench marks. The elevations in the precise level net are referred to mean sea level. The mean surface of the water at the starting points was derived from long series of tidal observations. Mean sea level is the natural and the best datum for a level net. In the first place, it is a fundamental datum, for it can be reproduced; again, with it, leveling can be started at many places with certainty that when the different lines are joined the agreements will be close. Also, leveling by different nations will agree when it is connected on the international frontiers.

There should be only one datum for the whole country, and this is only possible after the level net has been extended to such an extent that no place is far from a precise level bench mark.

The instrument used by the Coast and Geodetic Survey in its precise leveling is generally known as the "United States Coast and Geodetic Survey precise level." Its noteworthy features are that it is made of an alloy of nickel and iron which has a very low coefficient of expansion; its bubble is set down into the telescope near the axis of collimation; and its binocular system, by which the observer can see the bubble, cross wires and rod at the same time. The instrument was designed and made in the Coast and Geodetic Survey Office. It has proved very effective in enabling the observer to avoid or eliminate many of the errors which were in the leveling done with the older types of instruments.

All lines are run at least twice, in opposite directions. To be acceptable the two runnings of a section must agree within four millimeters times the square root of the distance in kilometers.

The average progress in the work per month is now about 86 miles for each party. The maximum progress ever made by one party was in October, 1914, when 148.3 miles were completed. The rapidity with which leveling is now done is due mainly to the use of the motor velocipede cars as the means of transporting the members of the party and to the more efficient organization and management of the leveling parties.

The great accuracy of the leveling is indicated by the probable error of the elevation at St. Paul, Minnesota (the least accurately known place in the net) resulting from the 1912 general adjustment of the level net of the whole United States, which is only $\pm$ 0.065 meter ($\pm$ 0.21 foot). The average correction to the lines forming the net for loop closure is about 0.15 millimeter per kilometer. An investigation of the small systematic and accidental errors in the precise leveling indicates that, when the ground is sloping, more accurate results are obtained on a cloudy afternoon, with a moderate wind blowing, than under the reverse conditions. When the ground is nearly level, the time of the day and the atmospheric and weather conditions do not seem to have any material systematic effect on the line of levels.

The Engineer Out in the World: MARTIN SCHREIBER.

The Teaching of Industrial Economics and Management to Engineering Students: HUGO DIEMER.

Recent engineering curricula show that instruction in industrial economics and management is being introduced in an increasing number of institutions. Examples are cited from the curricula of a number of well-known universities and colleges. Statistics regarding the positions held by the membership of the leading national engineering societies show that more than half of the com-

bined membership of these societies consists of men engaged as executives in manufacturing or contracting work. In such work ability as an inventor is less essential than familiarity with principles and applied methods of industrial management.

The speaker outlines the course in industrial engineering given at the Pennsylvania State College.

This course contains all the fundamental mathematics, underlying science and mechanics given in the standard engineering courses, but in place of the more technical work in designing and testing we introduce work in organization, management, theory of accounts, factory accounting, foundry and pattern-shop methods and organization, machine-shop methods and organization, factory lay-out and design and application of such methods of scientific management as planning departments, including orders of work, bulletining, making of time studies, preparation of introduction cards and tool lists, keeping of cost records and accounts on commercial work actually sold, on the one hand, and certain essential exercise work, on the other hand. The degree obtained by students graduating in this course is that of Bachelor of Science in Industrial Engineering.

Methods and New Apparatus for Measuring the Electrical Conductivity above 1500° C. of Vapors at Normal Pressures: Edwin F. Northrup.

The electrical conduction of gases and vapors at atmospheric pressure at temperatures above 1200° C. have apparently been little investigated quantitatively. If the investigation is to extend to metallic vapors means must be provided for producing and measuring very high temperatures, and if high pressure can be combined with high temperature, a searching experimental method will be provided of ascertaining the true nature of metallic conduction. Some progress is reported in providing the necessary outfit for the investigation of gaseous and vapor conduction at atmospheric pressure and at temperatures up to the melting point of platinum.

A furnace is described which gives safely a temperature above the melting point of platinum and which will maintain a temperature above the melting point of nickel for at least 140 hours. The furnace can then have its life renewed by the introduction of a new heater-unit. A container for the hot gases or metallic vapors is described.

It is shown that the conduction is considerable but complicated in character. It depends (1) upon the form of the container, (2) probably, upon the material of the container, (3) upon the applied voltage, (4) upon the direction of the applied voltage, (5) upon the temperature, (6) upon the frequency, when an alternating voltage is employed and (7) upon the nature of the gas or vapor.

A description is given of a series of measurements. The data obtained is given, partly in a table and in ten curves.

The considerable conductivity exhibited by a mixture of CO and N above a temperature of 1500° C. suggests the idea that the conductivity found for refractory oxides at and above this temperature is due in considerable part to the hot gases which fill the interstices of the material. This idea was put to the test of experiment and it was found that, under identical conditions in respect to method of measurement, cross section and length of material, etc., at the temperature of 1530° C. through pure aluminum oxide 36 milliampères and through a mixture of CO + N 8.5 milliampères passed, the pressure being 50 volts. Hence it is concluded that approximately 24 per cent. of the conductivity of pure aluminum oxide at this temperature is due to the conductivity of the gases in its pores. It therefore seems safe to make the general statement; *that when the temperature exceeds 1500° C., it is impossible to obtain even approximately good insulation by any means.*

One of the most interesting properties of the conducting power of a very hot gas is the asymmetry of the conduction. In a particular case, at a pressure of 80 volts, 15.5 milliampères passed from a tungsten wire, axially located, to the walls of a graphite cylinder when this wire was made negative, and 45 milliampères when this wire was made positive. The temperature in both cases being 1510° C.

The writer states that high-temperature investigation presents innumerable problems, and it is in his judgment the most fruitful field for chemical and physical inquiry which is at this time presented to chemists and physicists.

Saturated Vapor Refrigerating Cycles: J. E. Siebel.

The author analyzes the energy conversion in refrigerating cycles conceived to be operated perfectly reversible by a saturated vapor with negative specific heat (steam as a representative).

Accordingly, it is found that the work required to produce a certain amount of refrigeration in

such a cycle is greater than in a refrigerating cycle operated reversibly by dry vapor of the same medium.

In the latter case the relation between the work W and the produced refrigeration Q is expressible by the equation

$$W = \frac{Q(t - t_0)}{T},$$

while in the former it must be expressed by the formula

$$W = \frac{(Q + Q_1)\ (t - t_0)}{T},$$

Q_1 representing the amount of heat which is to be withdrawn in the compression stage to keep the vapor saturated in a cycle operated between the temperatures t_0 and t, T representing the temperature t in absolute degrees.

The Moment of Inertia in Engineering: D. J. McADAM.

1. Moment of inertia is so important in engineering that its mechanical meaning ought to be well understood and clearly defined.

2. Standard works on mechanics for engineers and mechanics of engineering show that they lose sight of the mechanical effect which it represents and define it and use it as "a name given to a quantity much used by engineers"; and some engineers ridicule radius of gyration as "not being a radius and having nothing to do with gyration."

3. The source of the difficulty in the minds of the users of moment of inertia is: (*a*) Dread of calling inertia a force. (*b*) Failure to see that one of the factors in the square of the arm in the moment is a reducing factor.

4. The ordinary definition of moment of inertia is a secondary statement. It is simply a statement of the result of an algebraic multiplication in form of an algebraic formula; or it is a statement of the method of getting that algebraic formula.

5. The true definition of moment of inertia must define it as the moment of forces just as truly as any other moment of forces. And it must state the unit of force or acceleration in which the forces are expressed.

6. *Definitions.*—(*a*) The moment of inertia of a *particle* with reference to a point is the moment of the force, which acting upon the particle constantly at right angles to the line joining the particle to the point and acting constantly in the same plane, will produce radian acceleration.

(*b*) The moment of inertia of a *beam* at a section is the sum of the moments of the forces which are acting on the various elements of the section when the outer elements are stressed, so that there is unit stress at unit distance from the neutral axis.

7. It is to be observed that in (*a*) the unit force is one producing unit acceleration, and in (*b*) the unit force is unit intensity at unit's distance from the neutral axis. Both are forces, however, expressed in terms of a unit force.

8. In the expression for the moment of inertia of a mass about an axis parallel to the axis through its center of gravity, the term to be added to the moment of inertia of the body about the axis through its center of gravity is the moment of the force which will have to be applied to the mass at its center of gravity to cause it to have radian acceleration. This we find to be $FR = MR^2$.

The Use of Electricity in the Manufacture of Portland Cement: MALCOLM McLAREN.

Motors were first used in cement manufacture for driving light machinery in the outlying portions of the mill. As the mills increased in size the use of motors became more general, until now in many cases the entire mill is operated by electric power.

A method is given for determining whether, in an existing mill using steam engines for driving the machinery, it would be advisable to adopt electric drive. It is shown that the mill output should be increased by the change, but that the greatest saving in operating costs would be due to the fact that the steam economy of the steam turbines used with electric drive should be much greater than that of the engines they would replace.

Considering the question of whether the cement company should generate its power or purchase this from a supply company, it is shown that the cost of power per unit depends largely on the amount of power developed. A large supply system, therefore, which carries the combined load of many customers, should be able to produce power at a lower rate than could be done by any of the smaller constituent companies.

Various Engineering Problems in Connection with the Hydro-Electric Plant of the Housatonic Power Company at Bulls Bridge, Connecticut: CHARLES RUFUS HARTE.

Latest Developments in Marine Electrical Engineering: H. A. HORNOR.

This paper gives a brief review of progress in the development of marine electrical installations. It emphasizes the importance of electric steering, anchor windlass and other recent requirements. The possibilities of under-water communication are considered and improvements in searchlight projectors recorded. The essential points in connection with the introduction of electric propulsion and the opening field of possibilities not only in the design of efficient electrical apparatus but also in the effect upon the art of naval architecture are concisely stated.

The Nolachuckey Hydro-Electric Plant of the Tennessee Eastern Electric Company: W. V. N. Powelson.

The Location and Maintenance of Railroads and Highways along Steep Slopes: Walter Loring Webb.

The paper describes the development of a new principle of construction, when it is necessary to place the roadbed of a railroad or a highway along a slope which already is so steep that any increase in the rate of the slope, made by forming the side slopes above or below the roadbed, causes frequent slides. The usual practise has been to construct retaining walls on the upper or the lower side of the roadbed (or perhaps on both sides) which are necessarily expensive, since they must always sustain a great weight of earth. The method described utilizes the skeleton construction permissible by reinforced concrete and reduces to a minimum the stresses which must be sustained by the structure. An illustrated example of the application of this principle, as developed by the writer in Oil City, Pa., is given in detail. Another illustration of the same fundamental principle, as recently described in the technical press, is also given.

Construction of the New Double Track Tunnel of the B. & O. R. R. through Alleghany Mountains at Sand Patch, Pennsylvania: Paul Didier.

Reconstruction of Bridge No. 100, Pittsburgh Division: J. C. Bland and John Miller.

This bridge, situated a little west of Coshocton, O., was partially destroyed by flood in March, 1913, and the wrecked spans temporarily replaced by girder spans.

The structure, before the flood, consisted of four double tracks through pin-connected truss spans, each 152 ft. 2 in. c. to c. end pins, and was replaced by three double track, through riveted truss spans, each 240 ft. c. to c. end pins. The total shipped weight of the three spans was 2,740 tons.

The old masonry was replaced by new concrete piers and abutments, the foundations for these being sunk by pneumatic caissons. This new masonry was built by the Foundation Co., of New York.

The new bridge was erected on falsework on the downstream side of the old, and when completed, was used as a run-around to carry traffic while the old structure was being dismantled. The new spans were then rolled into position.

Both the weight moved, 3,250 tons, and the distance moved through, 44 ft. 9 in., constitute a record for an operation of this nature.

The new steelwork was manufactured by the American Bridge Co., of New York, and was erected by the Seaboard Construction Co.

The bridge was designed by Mr. J. C. Bland, engineer of bridges, Penna. Lines West of Pittsburgh, under whose supervision the erection also was carried out.

A Balanced Cantilever Bridge: Henry H. Quimby.

A bridge of a new type was recently constructed at Chester, Pa. It consists of two independently acting parts, each being a double cantilever of ten longitudinal ribs of reinforced concrete resting on a pier over which it is balanced with a counterweight, the channel ends of the cantilevers being connected by a short so-called suspended span, and the whole forming in appearance a concrete arch.

The type was devised as the most economical method of securing an ornamental arch bridge which was desired at this point by the public authorities for esthetic considerations, the subsurface conditions making a real arch very expensive. These conditions consisted of deep soft mud on one side of the river underlaid with a bed of rock sloping steeply away from the channel to a considerable distance and depth, affording no natural skewback for an arch to thrust against.

The pier on the deep mud side is on wooden pile foundations with concrete capping, lateral stability being obtained by surrounding the pier with spur or batter piles.

The bridge is one hundred and sixty feet long over all, with the main span ninety-five feet centers of piers, and the wings thirty-one and thirty-four feet, respectively. It is sixty feet wide, with cartway thirty-six feet between curbs.

The action of the double cantilever is that of the double overhanging gantry crane, the dead load balanced with equal moments over the middle

of each supporting pier, and the traveling live load shifting the center of combined load forth and back over the middle within a range not exceeding one third of the width of the pier, so that tension is never developed at the edge of the bearing.

An open joint was made at one end of the suspended span to provide for temperature movements as well as to keep the cantilevers independent of each other, but the pressure of the earth fill against the ends of the bridge keeps the joint in contact and makes the bridge a real arch to the extent of that pressure, and giving it, under ordinary loads, all the rigidity of an arch.

The Newark Terminal: MARTIN SCHREIBER.

Cooperation between the Physicist and the Engineer: CARL HERING.

Defining engineering as "applied physics," and stating that the province of the physicist is to discover and formulate the laws of nature, while that of the engineer is to then apply these laws and data to the construction of useful structures —the author urges a closer cooperation between them, and shows how much the work of the engineer is dependent upon that of the physicist.

As illustrations of its importance he cites cases in which engineering structures failed due to incomplete statements of the laws of nature in books on physics; or in which in applying the physicist's laws it was found by the engineer that they were faultily stated, resulting in misleading or even wrong results. In other cases the engineer discovered new laws which it was the province of the physicist to have given him, the physicist being better equipped and trained for such research than the engineer.

The physicist taught nothing at all in his books about any internal forces in conductors due to the electric currents flowing through them, yet the engineer in his constructive work found them to exist. Maxwell's famous law of induction, as stated by the physicist, when applied to a specific case gave results which were contrary to the facts, as was found in the constructive work of the engineer. Physics says nothing about axial electromagnetic forces in conductors, yet the engineer finds them to exist. The physicist's work is the foundation of the structure of the engineer, and with an insecure or doubtful foundation, the structure is not dependable. Much time, money and failure can be saved to the engineer if the physicist gives him all the necessary data and states the laws of nature correctly and completely.

Attention is called to cases in which quantitative laws of certain physical phenomenon have not yet been established by the physicist. Overlooking the distinction between the physical and chemical parts of thermo-chemical processes is criticized.

Concerning units for measuring physical quantities, it is shown that the physicist is far ahead of the engineer and the latter would often save himself much work in his calculations by adopting decimal multiples of the absolute units, as was done in the case of the electrical units in which all the conversion factors are made unity by definition. Useless double units should be eliminated, but for some cases double units are advocated for eliminating the factor π from many calculations. In creating new units, physicists are urged to base them on the absolute system, to avoid the use of conversion factors. The physicist's unit of "brightness" of light is criticized as a physical inconsistency and as being an unnecessary double unit.

Numerous references are given to articles in which the topics touched upon are discussed more in detail. The author hopes that his illustrations will show the importance and the benefits of a closer cooperation between the physicist and the engineer.

The fourth session was held on the afternoon of Thursday, December 31, Mr. O. P. Hood in the chair, with an attendance of about 35. The program of the session was as follows:

Some Engineering Achievements in Philadelphia and Environs: EDGAR MARBURG.

The Hydraulic Laboratory of the Civil Engineering Department, University of Pennsylvania—Its Equipment and Operation: WILLIAM EASBY, JR.

Some Laboratory Accessories for Materials Testing: H. C. BERRY.

Correct Methods of Creating and Maintaining Channels at the Mouths of Fluvial and Tidal Rivers, and at the Outlets of Inclosed Tidal Areas: ELMER CORTHELL.

The Engineers' Interest in Deep Waterways with Special Reference to Mississippi River and its Tributaries: HARRY E. WAGNER.

The Tide Water Outlet of the New York State Barge Canals: D. A. WATT.

This paper presents a brief sketch of the work now being constructed by the federal government at Troy, N. Y., in order to provide a connection between tide water in the Hudson River and the

extensive system of state canals, known as the barge canal, now nearing completion by the state of New York. These new canals will provide a modern waterway, not less than 12 feet in depth, between the seaport of New York and the Great Lakes, with a spur running northward along the Hudson Valley to Lake Champlain. The work is practically a reconstruction of the existing system of canals, which have a depth of only 6 feet, but which, nevertheless, constitute an influential factor upon the freight rates of a considerable portion of the United States.

The works which will form the outlet at Troy of this great system will consist of a lock with two tandem chambers, which together will have an effective horizontal area of more than twelve times the area of the present single locks, and the dam will have a length of nearly a quarter of a mile. In addition to these works, between 20 and 30 miles of river channel have to be deepened an average of 3 to 4 feet, so as to provide the channel depth of 12 feet.

The American Bridge Company School Work at Ambridge: J. E. Banks.

Some Features of the Engineering Plant for the New Agricultural School near Farmingdale, New York: Ralph C. Taggart.

The Human Nature Element of Engineering Construction with Particular Application to Tropical Situations: T. Howard Barnes.

The Dome of the Columbia University Library: O. W. Norcross.

The Inspection Department in Its Relation to the Management of Manufacturing Organizations: Fred. B. Corey.

In this paper the author calls attention to the disadvantages inherent in the usual plan of factory organization, in which the inspection department is under control of the works superintendent, and to the great advantages to be gained by placing this department under authority of an executive reporting directly to the general manager, or other officer in control of the factory output.

The executive head of the inspection department should be thoroughly familiar with general engineering practise and standards. He should be well informed in all shop methods, including foundry and machine-shop practise, and be thoroughly versed in the use of testing machines and gages. He should, if possible, be conversant with chemical laboratory methods and apparatus, so as to be able intelligently to direct that part of his organization. Moreover, he should be familiar with the uses of the factory products and the conditions under which it is to operate after it has passed beyond control of the factory. He must have absolute control of every inspector in the plant and be held responsible for the quality of material and workmanship of all that the plant produces.

The relations that should exist between the inspection department and the sales and engineering departments are quite fully outlined. The inspection department, if rightly conducted, acts for the mutual protection of the manufacturer and the customer and can be of great assistance to the sales department in various ways. At the same time it should maintain the closest possible relations to the engineering department and plans are outlined by which practical cooperation may be secured.

Detail methods of inspection must be suited to the special conditions of each case. It is obviously absurd to try to apply big-shop methods to a small shop, and the converse application, while far more usual, is no more logical. Such matters must, therefore, be subjects of careful investigation and study in each individual plant.

The Application of Science to Telephone Engineering: George S. Macomber.

Reinforced Concrete as an Emergency Repair for Iron Chimneys: A. L. Pierce.

Mining Engineering Problems Incident to the Development of the South African Diamond Mines: Gardner F. Williams.

Shaft Sinking in Excessively Hard Rock: William Young Westervelt.

The Refrigerating Plant at the Washington Market, New York City: Charles H. Higgins.

Removal of Henderson Point at the Portsmouth Navy Yard: O. W. Norcross.

New Machine for Ginning and Cleaning Cotton: George T. Burton.

Spiral Wrappings with Special Reference to Flat Spiral Springs and Stresses in Steel: B. Spencer Greenfield.

At the conclusion of the session an inspection of the new engineering laboratories of the University of Pennsylvania was made under the direction of Professors Edgar Marburg, William Easby, Jr. and H. C. Berry.

Arthur H. Blanchard,
Secretary